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THE

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THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora and to establish suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Inquiries regarding membership may be directed to the state secretary or, from those residing where there is a chapter, to the appropriate chapter secretary. (The Southeastern Chapter is centered in the Detroit metropolitan area; the Huron Valley Chapter, in Washtenaw County; and the Northwestern Chapter, in the northwestern Lower Peninsula.) Dues are modest, but vary slightly among the chapters; in all cases, they include subscription to THE MICHIGAN BOTANIST.

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ANNOUNCEMENT

With this publication, the Michigan Botanical Club launches into a new venture, the final direction of which it would be premature to predict with precision. Something of the history and nature of the sponsoring organization may be found on page 4. Suffice it to say at this point that our intent is to issue a journal (semi-annually the first year) devoted to all phases of plant life in Michigan.

The contents of this first number will indicate something of the possible scope of such a journal. We will not neglect the "lower plants" (fungi, lichens, mosses, etc.), nor will we forget the interests of the lover of "wild flowers." We hope to challenge the amateur to more meaningful study of plant life, as well as to inform the experienced botanist. Brief news notes and observations will be welcomed by the editors, as will short scientific papers pertaining to the plants of Michigan and the Upper Great Lakes region. Contributions will be considered whether from the standpoint of classification, plant geography, ecology, local flora, or any combination of these or other approaches to the study of botany.

We shall, of course, include major news and announcements pertaining to the Michigan Botanical Club, as a means of communication among the chapters and the members at large. But we will in no way supplant the more frequent (and informal) duplicated newsletters and announcements issued by the individual chapters. It may be expected that on conservation issues, THE MICHIGAN BOTANIST will reflect the interests of the Michigan Botanical Club and its vigorous offspring, the Michigan Natural Areas Council. We plan to include regularly a section on important literature relating to Michigan botany, including listings of new maps, bulletins, journal articles, etc., in the hope that this feature will prove useful not only to individual naturalists but also to schools, libraries, camps, and similar groups.

We invite your attention to the specific information on page 2 (second cover page) and we invite your subscription (if you are not already a member of the Michigan Botanical Club). We invite also your comments, suggestions, criticisms, and ideas.

—The Editors

THE MICHIGAN BOTANICAL CLUB

Helen V. Smith

The Michigan Botanical Club, Inc., was organized May 31, 1941, under the name of the Michigan Wildflower Association. It functioned under that name until 1946 when it became the Michigan Association for Native Plant Protection. The present name was adopted in 1949. By the time the organization was a year old the course it was to take over the next 20 years was pretty well charted. The conduct of the business was vested in the officers and a Board of Directors, the constitution had been adopted and amended, numerous committees were at work, and both formal meetings and field trips were held. The aims had been defined as: conservation of the native flora, education through public schools of the state, research and publication, and inculcation of appreciation of native plants. The first recorded concern about wildflower sanctuaries was voiced at the October, 1941, meeting at which time the organization also voted to incorporate and to affiliate with the Michigan United Conservation Clubs (MUCC). Membership grew rapidly and by January, 1943, there were reported to be 243 members.

One of the earliest and most important projects was working for the passage of a native plant protection law which became effective in July, 1943. Due to wartime conditions and lack of a strong central purpose after the passage of the law, membership declined somewhat for a few years and became more centralized in southeastern Michigan. None of the several out-state chapters continued active much beyond the war years. The Southeastern Chapter, centered in Detroit, was organized in 1944 and for many years the large majority of the Club's members have belonged to that Chapter. One of the Southeastern Chapter's outstanding accomplishments has been its annual wildflower exhibit at the Detroit Flower Show. A flourishing Northwestern Chapter in the Traverse City area affiliated with the Club in 1957. The rapidly growing Huron Valley Chapter in the Ann Arbor-Ypsilanti area is the latest group to be admitted. The State organization, to which all chapter members automatically belong, now has about 450 members, about 40 of whom are members at large.

Among the accomplishments of the Club a few of the major ones can be mentioned. The Ecology Trail at Haven Hill was laid out with the aid of Botanical Club members. The independent and effective Michigan Natural Areas Council started as a committee of the Botanical Club. The Club also aided in the founding of the Detroit Museum of Science and Man and has always supported sound conservation policies. It conducts the Big Tree Project, during the course of which a number of National Champion Trees have been located in Michigan. The Club is now affiliated with the MUCC, Michigan Natural Areas Council, Michigan Parks Association, The Wilderness Society, and the National Parks Association.

With its launching of THE MICHIGAN BOTANIST and its record of past accomplishments, the Michigan Botanical Club may truly be regarded as having reached maturity during its 21st year.

AN OVERLOOKED LYCOPODIUM

Dale J. Hagenah
Cranbrook Institute of Science

Visitors to Mt. Washington and other New England mountains not infrequently come upon a dwarf tufted clubmoss growing among other alpine plants in rocky areas above tree line. This is *Lycopodium selago,* the Fir Clubmoss, a species found around the world in alpine and subarctic habitats.

Of the American clubmosses, the Fir Clubmoss most nearly resembles the Shining Clubmoss *(Lycopodium lucidulum),* a species known to most local field botanists, as it occurs throughout Michigan. Unlike the long trailing rootstocks of most of our clubmosses, these two have short underground stems from which arise clusters of aerial stems which may be several times branched, all of the branches ascending to form a cluster of leafy stems. The lower portions become prostrate on the ground and are covered by accumulating leaves and other litter. The leaves on these prostrate portions become yellowed and eventually disintegrate. Another character distinguishing the clubmosses of this group from others is the lack of cones, the yellowish spores being borne in little spore cases in the axils of some of the leaves of the aerial stems. Because of this lack of specialized cone structures for spore bearing, these clubmosses have been considered to be among the most primitive living vascular plants. In addition to their spores, both species bear little green buds (gemmae) in the axils of leaves near the top of the stem. These drop off and form new plants directly.

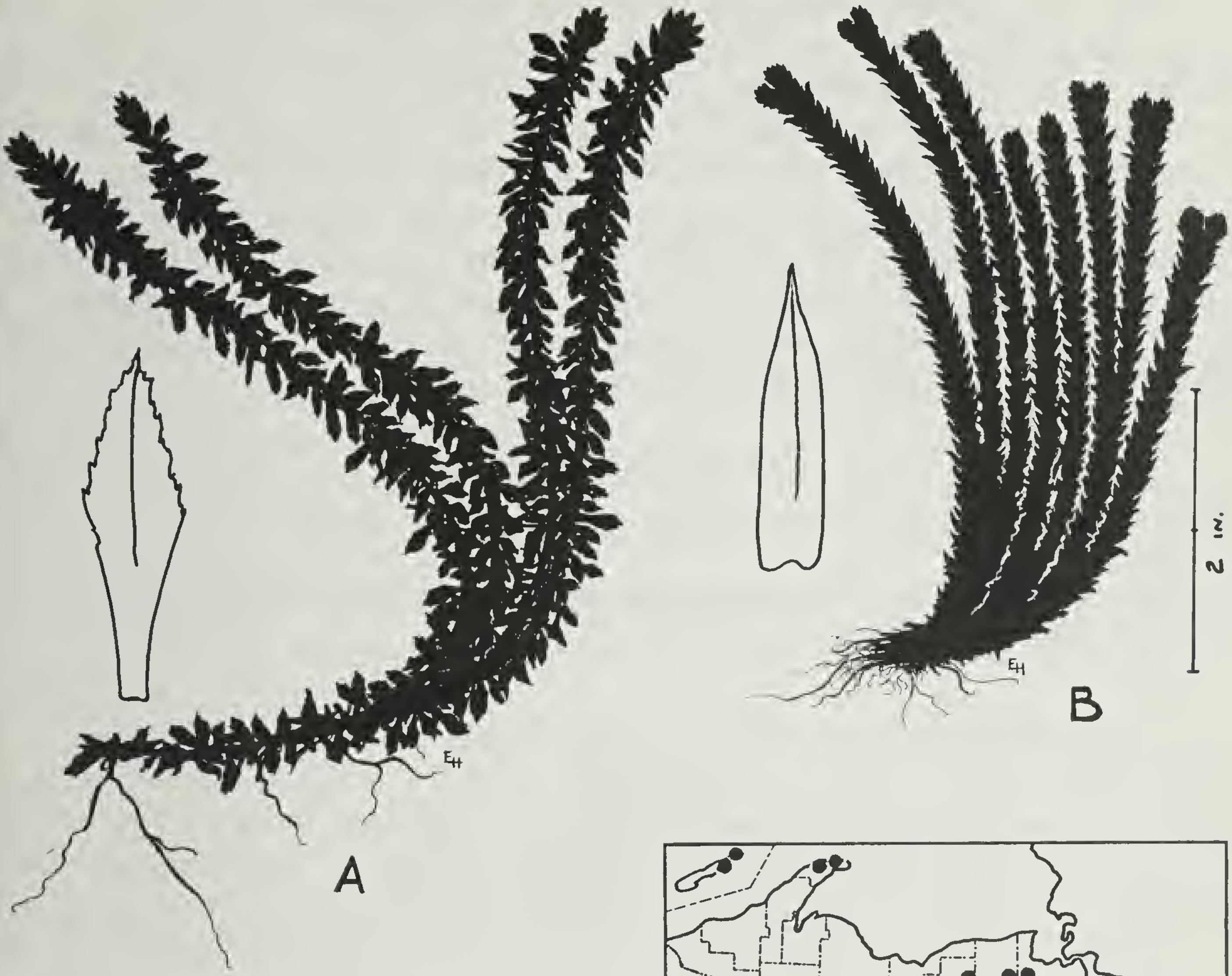
The extreme forms of the Fir Clubmoss, as seen above timberline, and of the Shining Clubmoss, in moist woodlands, may be separated easily. The former is a low (up to 5 inches high) plant with yellow-green awl-like leaves which are broadest near their attachment to the stem; are only slightly toothed, if at all; and are concave above. The Shining Clubmoss is a more robust plant (up to 10 inches high) with shiny dark green leaves. In the sterile zones where there are no spore cases the leaves are broadest half-way or more toward the end and have toothed edges, the teeth being distinguishable with a 5- or 10-power hand-lens. The leaves are flat and tend to become reflexed with age. Throughout the stem the leaves occur in alternately long and short zones, marking annual growth stages, and these, together with the reflexing of older leaves, tend to give the plant a ragged, uneven appearance.

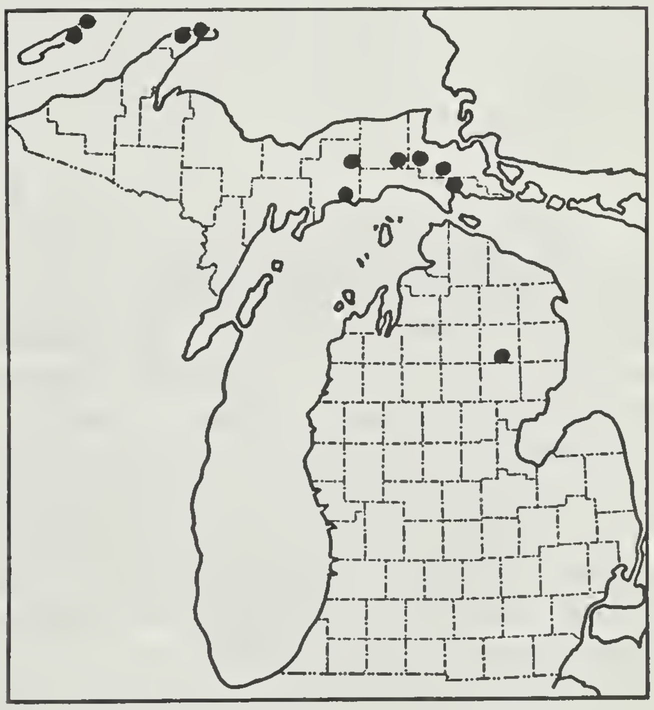
Like some other arctic-alpine plants when they occur at lower altitudes and in more temperate climates, the Fir Clubmoss or closely related plants grow larger and tend to be less compact in the southern part of their range. The annual growth stages are more evident, as in the Shining Clubmoss. Such variations have given rise to a series of plants some of which have been interpreted as species (e.g., *Lycopodium porophilum),* as varieties *(Lycopodium selago* var. *patens),* and as hybrids *(Lycopodium x buttersii).* There is a plant otherwise like the Shining Clubmoss but with narrow leaves that are untoothed *(Lycopodium lucidulum* var. *occidentale).* Botanical manuals and guides differ in their application of the names for intermediate plants. Perhaps one reason for confusion is that the Fir Clubmoss and the various intermediates are either rare or overlooked, even in the areas where the ranges of the two species overlap, as in the Appalachians and the Great Lakes region.

Ferns of Michigan (Billington, 1952) lists two localities for typical *Lycopodium selago* (Isle Royale and the mainland of Keweenaw County) plus these and one other locality (in Schoolcraft County) for the variety *patens.* In 1954 Jarl Hiltunen found a colony of the Fir Clubmoss in western Chippewa County growing under and among low shrubs in an excavation from which sand had been removed for highway purposes. This shallow "borrow pit," as such excavations are sometimes called by local highway people, lay along a swamp and thus had a water table close to the surface. Other interesting pteridophytes found there included *Equisetum palustre, E. variegatum, Botrychium simplex, B. matricariaefolium, B. multifidum, Ophioglossum vulgatum, Lycopodium inundatum* (a large colony), and other clubmosses, including *Lycopodium sitchense,* another very rare species (Hiltunen, 1961).

In 1959 I found a few plants of the Fir Clubmoss type in a similar but smaller excavation in Mackinac County. Since then, by concentrating on such excavated areas and moist sandy roadsides along swamps, other localities have been found in Luce and Schoolcraft counties. In May, 1961, Dr. W. H. Wagner, Jr., found a few plants in second-growth woods on a north-facing slope below a rocky hill at Scott's Quarry, Chippewa County. In June of 1961 some plants of this sort were found along the edge of a lake in southern Oscoda County by Ethelda Hagenah. Here they were growing along the old beach line of a lake in which the water level had dropped several inches. This is the first record for the Lower Peninsula of Michigan.

All of the new stations, with the exception of that at Scott's Quarry, have a common denominator in that they are relatively new habitats created by excavation, road construction, or, in the case of the Oscoda County locality, by a change in water level. It has long been known that such situations create new habitats for the Bog Clubmoss *(Lycopodium inundatum)* and other clubmosses; for various orchids, especially *Spiranthes* and the Club Spur Orchid *(Habenaria clavellata);* and for the Adders-tongue Fern *(Ophioglossum vulgatum)* and various Grape Ferns *(Botrychium).* The more southern stations for the Fir Clubmoss complex are usually on rocky ledges, as in Ohio and Indiana, but on Isle Royale and elsewhere in the Lake Superior region some stations are reported from the edge of lakes and margins





A LYCOPODIUM LUCIDULUM
NEGAUNEE, MICH.
B LYCOPODIUM SELAGO
MT. MONROE, N.H.
DRAWN BY ETHELDA HAGENAH
MAP: THE LYCOPODIUM SELAGO
COMPLEX IN MICHIGAN

of pools, situations more like the newly found Michigan stations. Evidently the Fir Clubmoss appears early in the vegetational succession of moist, sandy places.

Do these new colonies develop from windblown spores or are the little gemmae carried from place to place by some means? In either case, where do they come from? Are there other long established colonies which have been overlooked? The fact that five new and scattered stations were found in two years suggests that these plants may be more widely distributed than we have realized, but that they are overlooked or mistaken for the more common Shining Clubmoss.

The Fir Clubmoss group provides interesting problems in plant geography, ecology, and taxonomy. The discovery of more stations should make it possible to better understand the species and its variants. I would be happy to receive specimens from anyone who suspects that he has located this species. Caution: Since some stations have only a few plants, collect only enough for a voucher. Do not exterminate the station. Good locality data that will enable others to locate the station for study of the plants are essential. A small sketch map which locates the station in respect to a road junction, stream, or other landmark is very useful.

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To Be Expected

The following special features are among those on hand for the next issue of THE MICHIGAN BOTANIST: a report on the Big Tree Survey of the Michigan Botanical Club, by Paul W. Thompson; the first in a series of ''Michigan Mushroom Notes'' by A. H. Smith, which will emphasize species not included in *The Mushroom Hunter's Field Guide;* an article on growing the green dragon *(Arisaema dracontium)* by the late Emma J. Cole—the first in a series of short articles from manuscripts by botanists no longer living.

If there is interest (and a flow of contributions) from our readers, regular features might be begun in two categories: questions and answers about plants, and interesting distribution records extending known ranges of plants significantly in the Great Lakes region.

Now that our first issue is distributed, all persons with material to contribute—whether articles, short articles, short notes, or items for regular features such as "Program Notes"—should be aware of the opportunity and respond appropriately.

NOTES ON THE LIFE HISTORY OF *CAMPANULA AMERICANA*, THE TALL BELLFLOWER[1]

Stanwyn G. Shetler
Department of Botany, The University of Michigan

The bellflowers or bluebells have long been favorites for the ornamental garden or border, and flower gardeners the world over, familiar with the legendary Canterbury Bells (*Campanula medium* L.) or ever-popular Bluebells of Scotland (*C. rotundifolia* L.), need no introduction to this genus. Wildflower enthusiasts and botanists, on the other hand, may not be familiar with some of our native species. Seldom common in the usual sense of the word, the native bellflowers are always a delight to find and well worth the trouble of seeking them out.

The genus *Campanula* is comprised of perhaps 300 or more species, mainly North Temperate, but less than two dozen of these are native to North America.

Any of the numerous other species cultivated in American gardens may however become locally naturalized. (See Crook, 1951, and Bailey and Lawrence, 1953, for interesting accounts of the numerous cultivated species.) Considering the North American flora as a whole, *Campanula* is a small and insignificant genus, although it may be locally prominent, but what this group of plants lacks in numbers it makes up in aesthetic appeal.

The Tall Bellflower is uniquely American (i.e., endemic to North America), and it is unquestionably the most distinctive American species. In fact, it has few if any really close relatives in the entire genus. Characteristically a meter or even two in height and strictly erect in habit, this stately species often towers over surrounding vegetation. Branched plants, usually common, tend to be rhombic or pyramidal in outline, reminding one of some exotic candelabrum, since the branches become shorter toward the top of the plant and are completely absent from the terminal third of the stem. This wand-like terminal portion is densely floriferous at the peak of flowering. Contradictory to its name, the Tall Bellflower does not have bell-shaped flowers, but rotate (open, wheel-shaped) ones. This feature combines with the peculiar S-shaped—proximally declined and distally upcurved—style to give the flower a most distinctive appearance (fig. 1).

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[1] This paper is based largely on a thesis completed at Cornell University in partial fulfilment of the requirements for the degree of Master of Science. The fieldwork was carried out in northwestern Somerset County, Pennsylvania, during the summers of 1955 and 1956. I wish to express my sincere thanks to Robert T. Clausen, Department of Botany, Cornell University, for advising me in this study and to Elfriede Abbe, Scientific Illustrator, Cornell, for the nicely executed line drawings. The map is based on specimens seen in the following herbaria: Aquinas College, Cornell University, Harvard University, Michigan State University, Olivet College, University of Michigan, U.S. National Herbarium. I am grateful to the curators for making the specimens available on my visits, and to Warren Stoutamire for supplying records from the Cranbrook Institute of Science.

Liberty Hyde Bailey once wrote (1953), p. 2), "The bellflowers appeal for the most part to the quieter and restrained emotions. Most of the species are not impertinent and gaudy, nor do they lend themselves to display." Apter words could not be chosen for the Tall Bellflower. Never conspicuous for its abundance or showy flowers, it has nonetheless a unique beauty, ·owing to its stately habit and cleancut azure corollas pierced by that peculiar style. It was this unique beauty that drew my attention to *Campanula americana* L. several years ago, while I was studying the local flora in southwestern Pennsylvania. Subsequently, I set about to learn something of the life history of this species in that region by tagging individual plants and flowers in nine local populations. Although the several generalizations presented here are based primarily on that work (Shetler, 1958), it seems reasonable to assume that the life cycle is basically the same in our region.

Detailed life-history studies of individual plants hardly seem worth the tedious effort. But the elementary details of life history are not known for some of our commonest plants, and one might hope that more amateur botanists would take up this type of research. A keen and painstaking observer can with a few simple tools—tags, pencil and notebook, ruler—make observations which, if accurate, are quite important to the overall picture.

DISTRIBUTION AND HABITAT

Campanula americana is widely distributed throughout the deciduous forest regions of eastern North America from Long Island through southern Ontario to Minnesota and south to Kansas and the Gulf States. It stops abruptly where the boreal forests begin and is scarce in the northern hardwood regions. In Michigan it is widely recorded from the southern half of the Lower Peninsula (see map, fig. 2). One dubious record shown for Manistee County is north of the main region.

This bellflower inhabits moist borders and open woods and does not seem to thrive well in dense shade or completely exposed places. Very frequently one encounters it on partially shaded roadbanks or streambanks.

FLOWERING CYCLE

An individual plant is in flower over a period of five to six, or as many as eight, weeks and during this time may produce more than 500 flowers. I have counted as many as 60 flowers expanded at one time on a given plant. The tops of these tall plants very frequently break off before the end of the growing season, and topped plants nearly always flower longer than the others because of the profuse lateral branching that is induced by the topping. The first plants begin to flower in early summer, and some plants are still flowering at frost.

POLLINATION

As in other bellflowers, the flowers are protandrous, meaning that within an individual flower mature pollen is always presented for dissemination before the stigmas of that flower are receptive to pollen. The period of pollen presentation begins in the bud where, just prior to opening, the five long narrow anthers form a tight column around the terminal part of the style, which is densely covered with short stiff hairs (fig. 3 a). The anthers dehisce longitudinally to the inside and shed their pale pink grains directly onto the hairy style. The minutely echinate pollen grains become enmeshed in the hairs and adhere tightly. The approximating of anthers and style is remarkably precise; I have seen filaments shaped like an "S," having the effect of shortening a stamen otherwise too long and thereby bringing the anther into the usual position for shedding pollen. Once the bud opens, the anthers wither quickly.

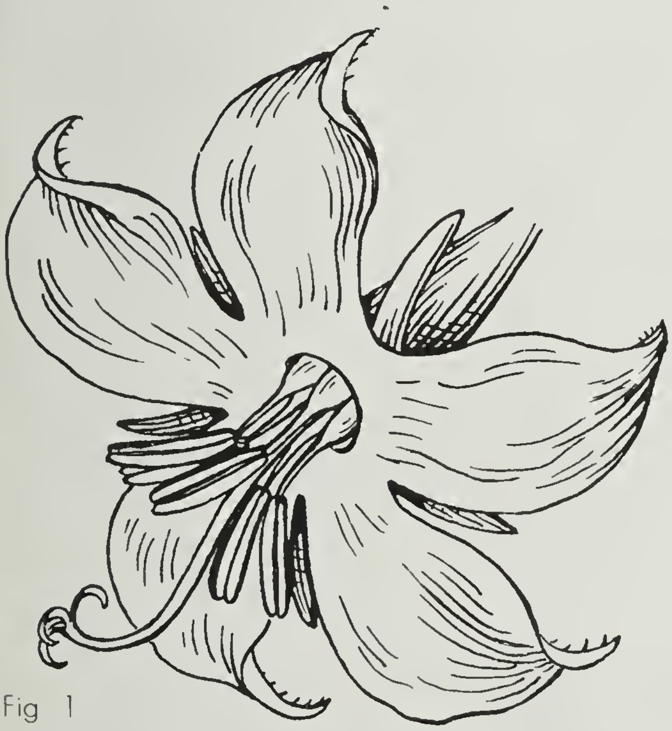

Fig 1

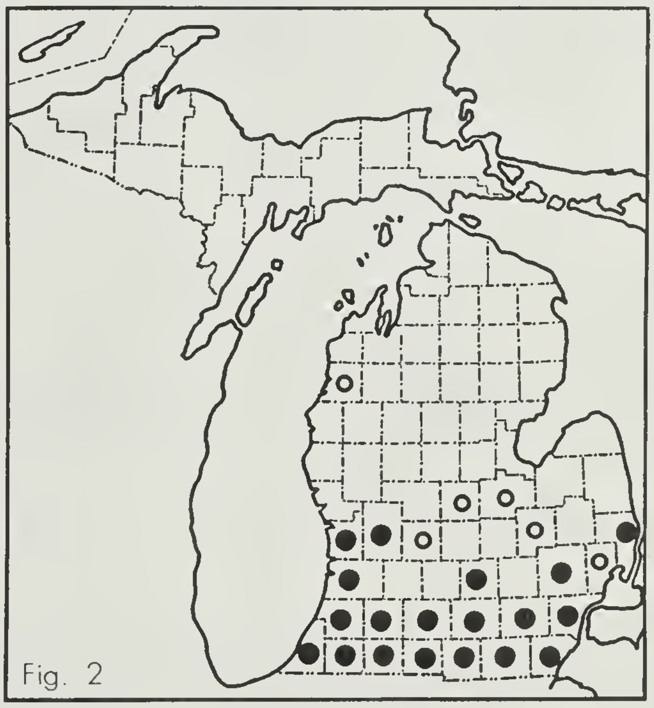

Fig. 2

Fig. 1. Characteristic rotate corolla of *Campanula americana* at about the time when the stigmas are receptive to pollen. (Approx. 2x)

Fig. 2. Distribution of *Campanula americana* in Michigan. Each solid circle represents a county for which herbarium specimens have been seen. The open circles represent older literature reports of specimens whose existence has not been verified.

Insects are the primary agents of pollination. A wide variety of Hymenoptera, Lepidoptera, and Diptera have been seen visiting the flowers. The deltoid-expanded base of each filament is nectariferous, and the five filament bases form a tight dome over the top of the ovary (fig. 1), which is also nectariferous. The moment a slight opening appears between the petals as the valvate bud begins to expand, insects try to pry the petals apart to get at the nectar. As they thread their way in and out of the partly opened bud, the hairs of the style are gradually rubbed off, carrying the pollen with them. This hair and pollen removal continues for a period of hours until the style is denuded.

The buds always open in daylight hours, usually beginning in the morning. The corolla achieves full expansion in four to six hours and remains fully expanded for 24-72 hours, averaging about 48 hours. The condition of the whole flower seems to remain static through the night, showing no measurable growth. The corolla does not close at night, but may become less turgid and somewhat "cupped." Withering occurs only during daylight, all at once or petal by petal with one or more petals drying up several hours to a day before the rest. Flowers wilt very rapidly when collected; thus the Tall Bellflower is a poor bouquet species, and good herbarium specimens are not easy to make.

At the opening of the bud, the style starts to elongate rapidly, developing its unique S-curve. First it declines and then upcurves (fig. 3).

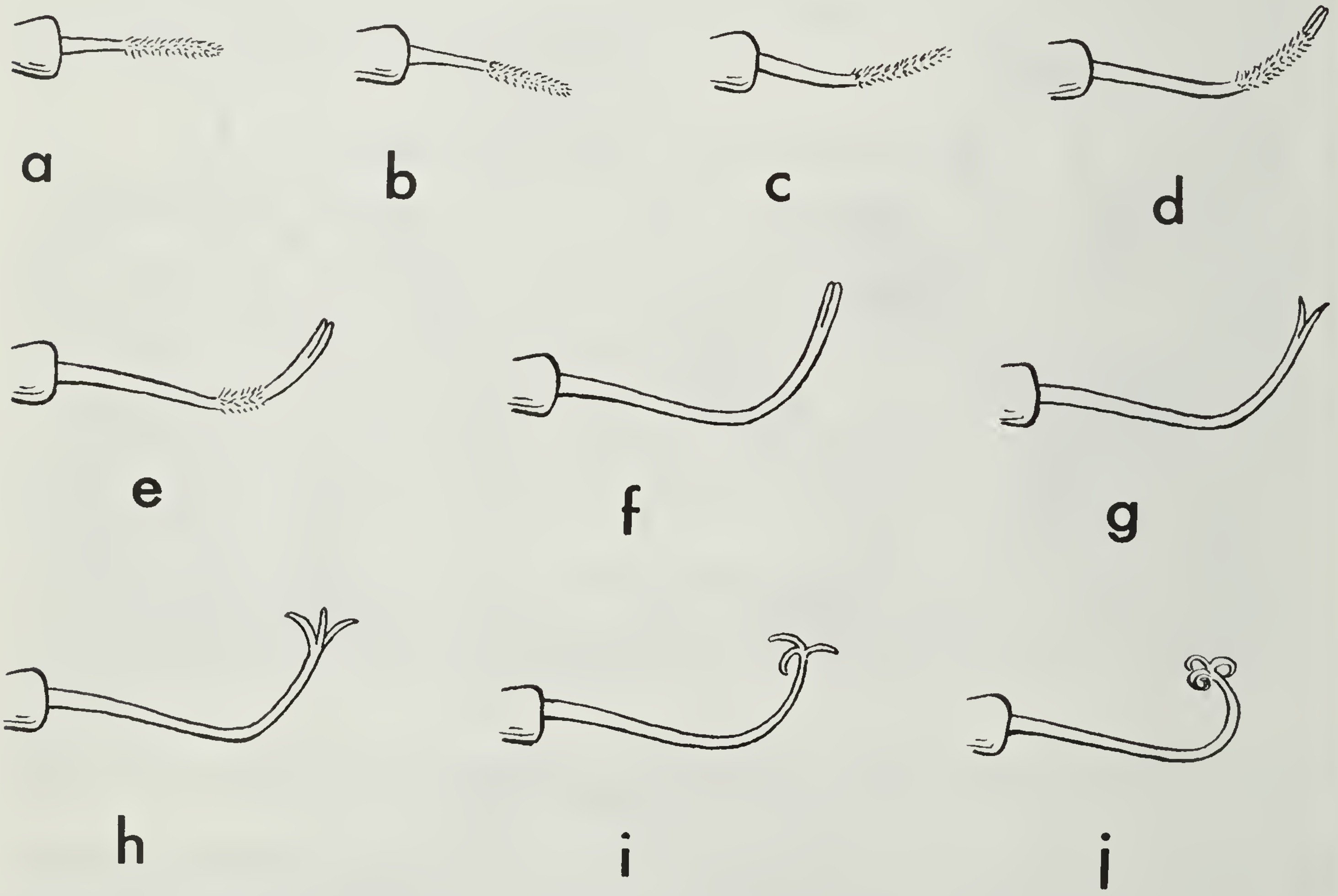

Fig. 3. Stages in the maturation of the style from the moment that the bud opens (a) to the beginning of withering (j). (Approx. 2x)

All the while the hairs with the pollen continue to disappear. There is no doubt that insects are primarily if not exclusively responsible for this hair-removal under usual circumstances, but whether or not they are indispensable is questionable. On rainy and late fall days when insect activity is low or nil, the hairs disappear much more slowly, but they do eventually disappear. I am inclined to think that the hairs are loosened by the rapid elongation of the style and would fall off sooner or later without mechanical aid. In the open flower, an insect can get to the nectar without brushing past the style (fig. 1), but some insects visit the pollen-laden style, perhaps for the pollen itself.

In fig. 3, the changes from the moment that the bud begins to open (a) to the point at which the style begins to wither (j) are illustrated. Despite many variations in the length of time required, this sequence occurs with amazing regularity from one flower to another. The hairs repeatedly disappear from the apex downward, a fact suggesting that hair-removal is more closely tied to style maturation than to insect activity, and the stigmas seldom expand before all the hairs, hence all the pollen, are gone. Exceptions to this relationship were found in late fall flowers when, owing perhaps to decreased insect activity, the hairs were late in disappearing, and stigma expansion frequently came before the style was denuded. On warm sunny days in mid-summer when insects are abundant the style usually is denuded by evening if the bud opened in the morning (fig. 3 f). The stigmas typically do not expand until the second day (g-i).

Although the stigmas are potentially receptive to pollen as soon as they begin to separate from each other, *precisely* when they are receptive was not determined. Measurable elongation of the style ceases just prior to stigma expansion (f), but no studies of pollen-tube growth through the style were made. Certainly, the stigmas must be receptive by the time they are wide-spread (i). This stage lasts for about a day and occurs when the corolla is at its best. Pollen grains adhere readily to the nearly horizontal upper surfaces of the stigmas. On the third or fourth day the stigmas recurve, touching the style, and the style itself begins to recurve and become flaccid (j). The entire style withers one to three days after the corolla has withered.

The brightly colored petals, nectariferous tissue, pollen-catching hairs of the style, and sticky echinate pollen grains all point to obvious adaptation for insect pollination, but the significance of the orderly time separation of pollen presentation and reception, at least under normal conditions, is not clear. Commonly, flowers in all stages of maturation occur on the same plant at once, and insects move indiscriminately from one to another. Self-pollination is undoutedly quite frequent, then, but is surely less common than if the stigmas were receptive at the time of pollen-shedding. When the stigmas do expand before all the hairs and pollen grains are gone, as happens in late fall, the possibility does exist for the individual flower to pollinate itself, because the recurving stigmas may touch pollen grains adhering to the style. I have not determined whether this species is self-sterile, and in the absence of information on this point one can only speculate about the breeding system. It seems likely that a considerable amount of outbreeding does occur.

SEED PRODUCTION AND DISSEMINATION

The capsule matures and sheds its seeds about six weeks after anthesis. In one sample of capsules the number of seeds per capsule ranged from 18-87, averaging 43. On this basis, a single plant, which may produce as many as 500 mature capsules, could discharge over 20,000 seeds. Seeds appear to be the only disseminules. The species is strictly annual, at least at most latitudes, and there are no adaptations for vegetative reproduction. The seeds are not adapted for wind dissemination and fall directly to the ground. Water seems to be the chief means of dispersal, and populations of Tall Bellflowers occur frequently in river valleys and near perennial or intermittent streams.

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MUSHROOMING IN NORTHWESTERN MICHIGAN

Ruth F. Hunsberger[1]
Traverse City, Michigan

The arrival of spring in Northwestern Michigan is a signal for mushroom enthusiasts to hie forth to the woods in search of that early spring mushroom, the morel.

For a display of caginess and downright evasiveness, just ask a native where he would suggest going to look for mushrooms! It reminds the writer of the days when the location of a good blueberry patch was something you just didn't divulge to everyone. And how about that fishing spot? Ever try to extract that information? Same thing seems to hold for mushroom hunting.

Some Northwestern Michigan localities are aware of the fact that the morel season is attracting the attention of people from all over Michigan and from out-of-state. In Charlevoix County, for instance, where the second annual National Mushroom Hunting Championship was held at Boyne City on May 13, 1961, registrations were noted from 18 different cities and 3 different states. The champion, a woman, picked 229 mushrooms in 75 minutes. TV and magazine coverage were given the 1961 event and the National Geographic Society was represented.

In Mesick, Michigan (Wexford County), the Third Annual Mushroom Festival date was May 6, 1961. Here prizes were offered for the best, the most, and the largest morels. Missaukee county, too, celebrated the mushroom season with a festival May 13 and 14.

Mushroom hunters know that the weather and the fact that mushrooms do not seem to follow a set pattern, make the hunting and "take" somewhat unpredictable. However, in spite of last year's poor weather conditions there were those who found enough to dry and freeze for later use. One man from Indiana, on the day of the Mesick Festival, displayed four bushels of beautiful mushrooms in the trunk of his car all ready for the homeward trip.

In the Mesick area "guestimates" indicated that usually about 1000 bushels of mushrooms are taken from the hardwoods and aspens. Missaukee County's estimate indicated that about 1500 people participated in their festival with the "take" there being approximately 1000 bushels.

Leelanau County guessed that over a 2-week period the total pick may have been 500 bushels. While these figures represent only a few areas in which morels are found, and though we know they are not all-conclusive, they at least give us a clue as to the importance of this favorite mushroom in Northern Michigan.

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[1] Consumer Marketing Information Agent, Michigan State University Cooperative Extension Service and U.S. Department of Agriculture, cooperating.

It might be interesting to note that morels sold for $1.00 to $1.50 per pound. In 1960 the price per bushel was $15.00; in 1961 they were selling for as high as $20 to $25 a bushel. Guides were available in the Mesick area this past year, as they no doubt are in other localities. The writer used a guide one late afternoon because of the unfamiliar territory. Five dollars worth of guiding yielded about a half bushel, which figured at the going rate was not bad.

As to how the morels are preserved, the most satisfactory method is reported to have been drying, but the growing use of home freezers has made this simple preservation method very popular.

The limited experience of the writer makes it impossible to say how large the harvest of mushrooms is or how widespread the use of morels may be. It is interesting to notice, however, the growing popularity of mushrooms, as shown by the increasing numbers of people who are coming to our northern forests in the month of May for the sole joy of searching for these delightful morsels. A quart or two may be the only visible reward for a day's search—but the privilege of roaming through the spring-time forests can never be underestimated. It would seem that the morel is another of the many incompletely explored natural resources of our state.

Gathering morels are Ben Redman and Ray (Sandy) MacDonald, of Mesick. (Photograph by Al Barnes, Traverse City.)

EDITORIAL NOTE—— The morel shown on the cover of this issue is the common morel or sponge mushroom *(Morchella esculenta)*. Two species are included in the photograph above, the common black morel *(M. angusticeps)* of northern Michigan and the early morel, *Verpa conica*, but the enlargement is not sufficient to show the distinguishing features. Morel season "opens" at about the same time as the trout season, and frequently the best hunting is along streams. The best morel hunting in Michigan is between May 5 and May 20, but the weather can shift this either way. As Mrs. Hunsberger has shown, morel hunting is becoming a major activity.

—A. H. Smith

POISON-IVY IN NORTHERN MICHIGAN[1]

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In Michigan, two infraspecific taxa of poison-ivy occur. One, Rydberg's poison-ivy, occurs chiefly north of the 44th parallel of latitude with a more southerly extension along the shores of Lakes Michigan and Huron (see fig. 1). The other occurs south of the 44th parallel. This paper concerns the plant in northern Michigan, which at this time is called *Toxicodendron radicans* (L.) *Ktze*. var. *rydbergii* (Small) Erskine (1960). A more complete nomenclatural treatment of the species and its infraspecific taxa will be published at a later time.

Poison-ivy had been collected sparsely in Michigan until the efforts of Dr. Edward G. Voss for the Michigan Flora Project and until my own studies on the taxonomy and ecology of the plant. Rydberg's poison-ivy has now been found in all counties of the Upper Peninsula and the counties of the Lower Peninsula north of the 44th parallel. It also occurs on sand dunes along Lake Michigan as far south as Saugatuck in Allegan County. It is found on the Keweenaw Peninsula, but not on Isle Royale. The rest of the state has *T. radicans* var. *radicans* in abundance. The map (fig. 1) is based on specimens in the herbaria of Michigan State University and the University of Michigan. (Exact citations of the specimens are available from the author.)

Chief among the differences between *T. radicans* var. *rydbergii* and var. *radicans* is the fact that var. *rydbergii* never climbs, nor produces aerial rootlets. The non-climbing habit in the field may be merely an indication of a juvenile form or the above-ground portion of a rhizome from a nearby shrub or vine. In a field situation, therefore, where one finds a vegetative, non-climbing specimen of poison-ivy, he cannot assume that it is var. *rydbergii* without submitting the individual to other morphological and ecological tests. Transplants to East Lansing from north of the 44th parallel in Houghton Co., Michigan, and Cass Co., Minnesota, have persisted for three seasons without losing their characteristic non-climbing habit or any of the other definitive characters given in Table I. Attempts to cross this variety with var. *radicans* were thwarted in 1961 by a late frost which killed the young buds.

In the original description of the taxon *rydbergii* (as *Rhus rydbergii*, after Per Axel Rydberg, 1860-1931), Small (in Rydberg, 1900, pp. 268-269) gives several diagnostic characters: "petioles 6-12 cm. long, leaflets . . . broadly ovate, often somewhat rhomboid [they

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[1] This research was sponsored by National Institutes of Health Grant E-3700.

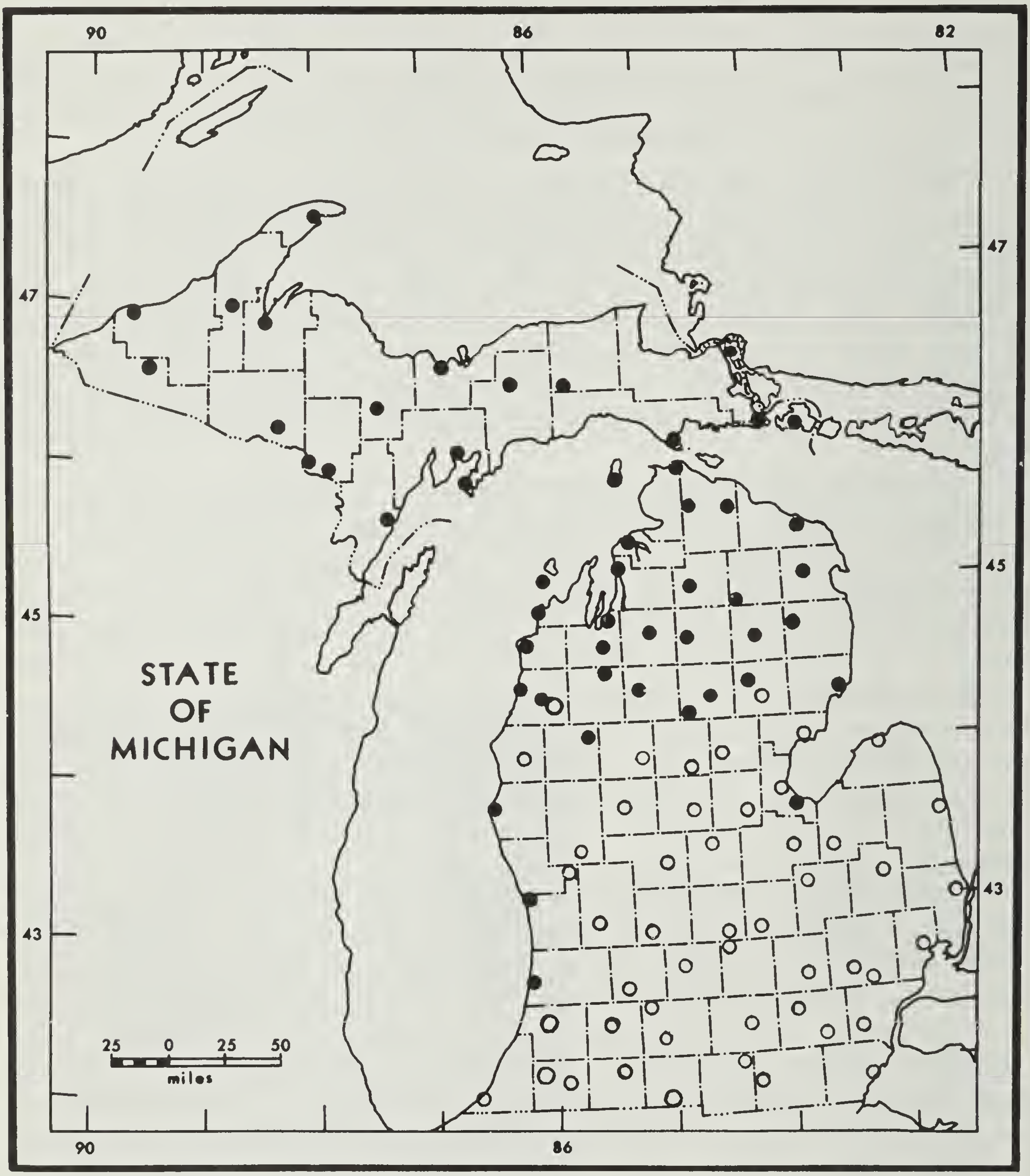
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Fig. 1. Distribution of poison-ivy in Michigan as represented by specimens in herbaria (MSC and MICH).

● *Toxicodendron radicans* var. *rydbergii*
o *Toxicodendron radicans* var. *radicans*

TABLE I. Comparison of *Toxicodendron radicans* var. *radicans* and *T. radicans* var. *rydbergii.*

Character	*radicans*	*rydbergii*
Habit	shrub, liana, prostrate vine, sub-shrub, epiphyte	sub-shrub
Habitat	Will seldom grow in woods that have abundant *Pinus* and *Pteridium*.	Will frequently grow in woods with abundant *Pinus* and *Pteridium*.
Geography	South of 44th parallel	north of 44th parallel.
Aerial rootlets	present	absent
Leaf aspect	flat or recurved	folded along midrib or spoon-shaped.
Leaflet shape	ovate to elliptic	broadly ovate to sub-orbicular
Position of leaves	scattered along branches	approximate at summit of branches, appearing falsely verticillate.
Petiole length	less than twice as long as complete blade	more than 1-1/2 times as long as complete blade.
Branching of inflorescence	generally branched	unbranched to sparingly branched
Flow number	generally more than 25 per inflorescence	generally fewer than 25 per inflorescence.
Filament color	cream to green	violet
Fruit cluster	erect or pendant	tight, erect
Fruit pedicels	present	absent or nearly absent
Fruit size	2.5-4 mm. in diameter	5-6 mm. in diameter

are almost orbicular] . . . with wavy or sinuately toothed margins; . . . fruit when ripe white and shining, a little depressed globular, 5-6 mm. in diameter." Attention is called further to the aspect of the leaves in their natural orientation. The leaflets tend to fold along the midrib, resulting in a spoon shape to each leaflet (fig. 2). Hence, they will be frequently found folded on herbarium sheets (fig. 3). Additional characters are listed in Table I.

In regard to the characters discussed, the variety shows some variation within itself, but it is surprisingly uniform. The leaflets are usually about as wide as long (orbicular or at least broadly ovate).

The margins may indeed be wavy or sinuate, but so may the margins of leaflets from climbing forms anywhere in the Midwest. To the trained eye, the leaflet margins of var. *rydbergii* have rounded teeth rather than angled teeth. The leaflet tip varies in degree of acuminateness, becoming more cuspidate toward the western edge of the range. The spoon-shaped aspect of the leaflets, mentioned earlier, is more pronounced in shady sites and where growing conditions are rigorous. The number of flowers and fruits in an inflorescence varies greatly with clones, some appearing to be almost sterile. Age of the population influences the actual number. Since the pedicels are never very long in the fruiting condition, the difference between subsessile and stalked is at times impossible to determine.

This non-climbing variety is not often recognized as distinct from var. *radicans* because of the provincial background of its observers. Those who live in parts of the country where poison-ivy does not climb do not relate the climbing plant to the non-climbing one. This was clearly demonstrated to the author in northern New Hampshire where residents scoffed at the suggestion that poison-ivy might be a climbing vine. That var. *rydbergii* grows consistently north of the 44th parallel is somewhat amazing, especially since cognate non-climbing forms follow the same geographical pattern in the Orient. The poison-ivy of northern Hokkaido (north of the 44th

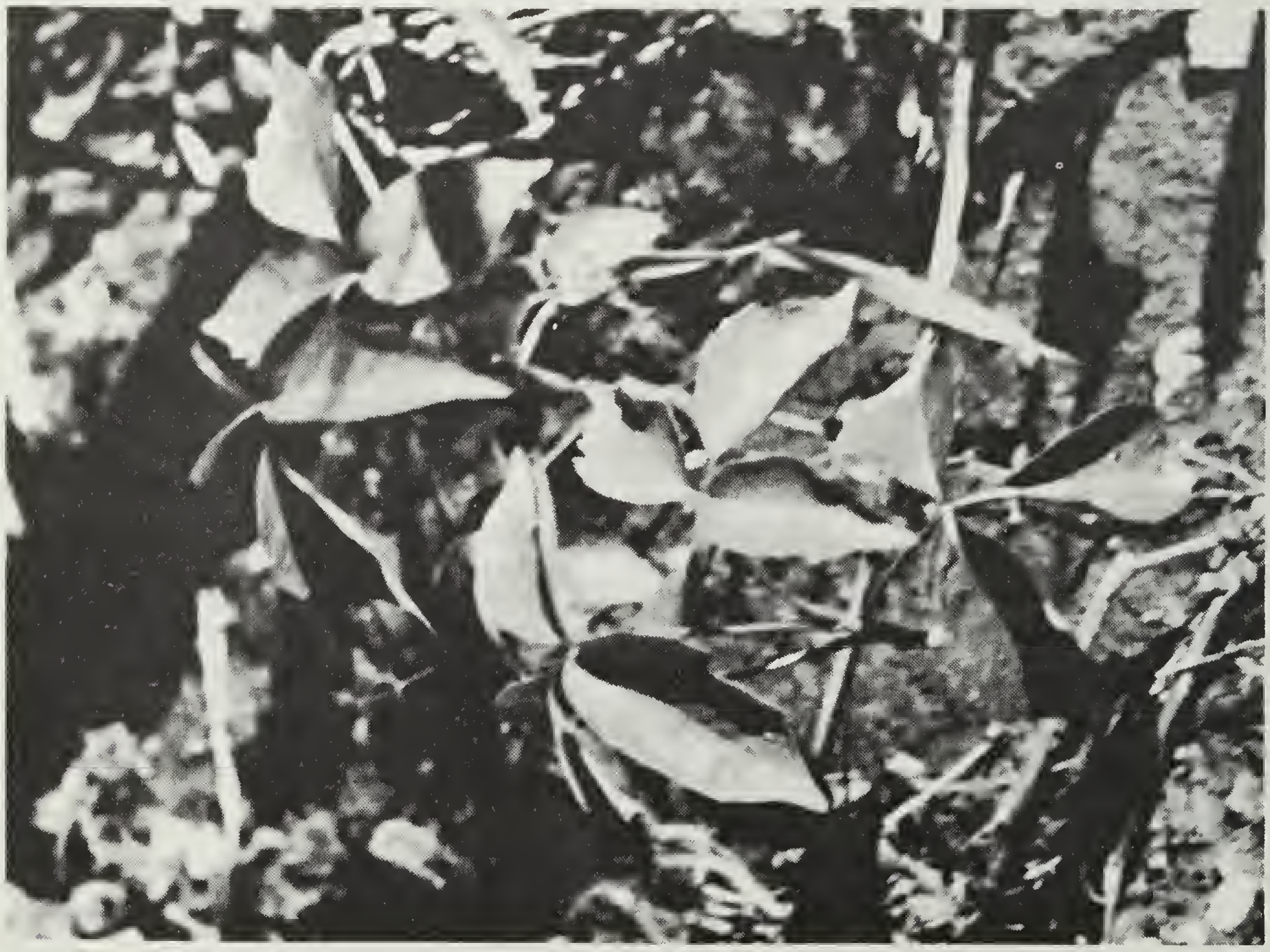

Fig. 2. *Toxicodendron radicans* var. *rydbergii (Gillis 3152,* MSC) growing on the escarpment at Lake of the Clouds in Ontonagon County, Michigan. Note spoonlike aspect of the leaflets.

parallel), Sakhalin, the Rishiri Islands, and the Kurile Islands has been recognized as distinct from the more southerly climbing populations and called *Rhus rishiriensis* by Nakai (1922). The relation of this plant to *T. radicans* var. *rydbergii* is still in doubt, but it is conspecific with American poison-ivy in its broadest sense.

Although present in every county in Michigan, poison-ivy is not common in northern Michigan; in fact, it may be characterized by its uncommonness in contrast to its more abundant southerly relatives. Its preferred habitats are stream banks, shallow rocky soil, sandy lake shores, and sand dunes. Whereas floodplains are almost invariably a home for var. *radicans*, they are only a possible habitat for var. *rydbergii*. In disturbed sites where soil is altered or even introduced (roadsides), the weedy nature of poison-ivy permits it to be present. Rydberg's poison-ivy is commonly found in sands along with abundant pine and bracken fern, but the ecological niche of var. *radicans* does not include an environment of pine and bracken.

SUMMARY

This paper shows the range of *Toxicondendron radicans* var. *rydbergii* in Michigan, including some new localities. It also delimits the differences between var. *rydbergii* and var. *radicans*, so

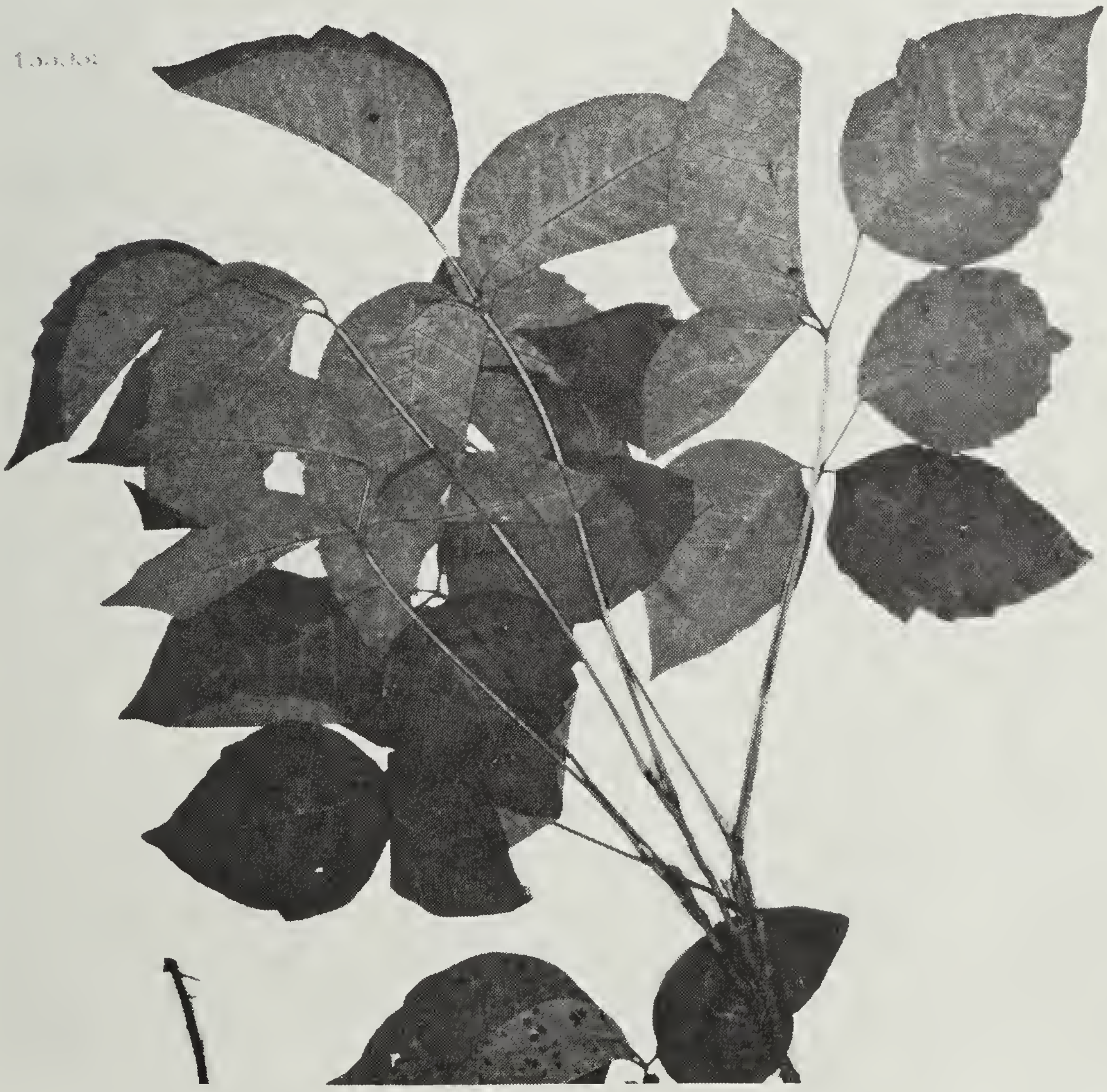

Fig. 3. Portion of a herbarium specimen *(Waterman 372,* MSC) of *T. radicans* var. *rydbergii* from Menominee County, Michigan. Note folded leaflets.

that botanists may be able to recognize the differences in the field.

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Ailanthus Promotion a Fraud?

Some of our readers may have been amused, or even incensed, to receive advertisements last year from a ''nursery'' in New Jersey offering plants of the tree-of-heaven *(Ailanthus altissima)*, which was ''predicted to be the most popular shade-tree in America by 1965.'' Other phrases referred to a ''very limited supply'' and stated that ''supplies are so scarce. . . .'' Much was made of the fact that this plant is ''written up'' in books found in leading scientific libraries and that it grows in most of the capital cities of the nation. Of course, dandelions and other attractive but weedy plants are also written up in botanical literature and grow in capital cities, as any intelligent reader would realize. The advertisers could have added that the plant is ''written up'' by the U.S. Forest Service— with these words: ''Cultivated and widely naturalized as a 'weed' tree. . . .''

The promoters of *Ailanthus* were convicted in Federal Court in Detroit on July 13, 1961, on 11 counts of mail fraud involving a ''gas-saver'' device for automobiles. Whether the Post Office Department seeks further prosecution under the mail fraud statutes for the *Ailanthus* promotion, about which there have been many complaints, remains to be seen.

— E. G. V.

NOTES ON THE FLORA[1]
OF CHIPPEWA COUNTY, MICHIGAN

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Since 1956, I have been making detailed observations and collections of the vascular plants of Chippewa County. The specimens collected have been placed in the herbarium of Wayne State University, Detroit. In the county certain areas and habitats have become more familiar as they often yield rare or otherwise interesting species. The present notes are concerned with two such areas—Sugar Island and Drummond Island. Previous important lists for these areas, respectively, are by Hermann (1937) and Winchell (1861).

SUGAR ISLAND

Sugar Island, located in the St. Mary's River east and southeast of Sault Ste. Marie, has been the area first to receive my attention, mainly because it is the place of my boyhood home. It is, therefore, that part of the county with which I am most familiar. The island is about 15 miles long and at its greatest width measures about seven miles. Due to the irregular shape its area is only about 50 square miles.

Although several interesting species could be listed from a number of habitats, I shall mention only two selected habitats, woodland and aquatic, and list some of the more unusual species from each.

The woodlands are roughly of two types, lowland and upland. The former type of woodland has generally a predominance of evergreen conifers whereas the latter has mostly deciduous trees. In the lowland woods I have found an orchid rare in Michigan. This is the auricled twayblade, *Listera auriculata*. Two or three plants were found growing together in soil that was a loose humus with sand underneath. This record of the species represents only the third county from which it is known in the entire state. (The others are Keweenaw County [Isle Royale] and Schoolcraft County.) In the upland woods I have found another rare species, the grapefern *Botrychium lanceolatum*.

Dr. W. H. Wagner, Jr., of the University of Michigan, recently discovered that the ternate grapefern, *B. ternatum*, grows in North America (Wagner, 1959). Subsequently, it was my good fortune to find, on Sugar Island, a plant which Dr. Wagner identified as the ternate grapefern. The specimen was found with several individuals of another grapefern, *B. dissectum*. Neither species was previously known from the county. Furthermore, the ternate grapefern was the first to have been reported from the Upper Peninsula.

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[1] Contribution No. 81 from the Department of Biology, Wayne State University, Detroit, Michigan.

Sugar Island is surrounded on all sides by the branches or channels of the St. Mary's River. The north channel of this river has two enlarged sections, Lake George and Little Lake George. The plant community to be considered next is on the Sugar Island shore of Little Lake George. The shoreline of this body of water is bordered by a thicket of willows, mostly of the shining willow, *Salix lucida*. Moving toward open water one finds a dense, emergent stand of the spike-rush, *Eleocharis smallii*, and the water horsetail, *Equisetum fluviatile*. Immediately next to this zone is the plant community of special interest. At this spot the bottom is of a soft clay-mud, whereas elsewhere along the shore this zone is of sand or tough clay. The nature of the bottom, undoubtedly, plays an important role in determining which species can grow there. The following are the dominant species found in the soft-bottomed area: quillwort, *Isoetes riparia*, awlwort, *Subularia aquatica*, water lobelia, *Lobelia dortmanna*, arrowhead, *Sagittaria graminea*, and three species of water-milfoil, *Myriophyllum alterniflorum*, *M. exalbescens*, and *M. tenellum*. The quillwort grows in dense mats and often crowds out all other vegetation. This species of *Isoetes* (determined by J. H. Soper, 1961) has not been previously reported from Michigan. The record of the awlwort is only the second known from the state, the other being from Isle Royale, Keweenaw County.

In the summer of 1956, the mean depth of the water in this area was about three feet. The water lobelia was seen completely submerged and with unopened flower buds. However, such was not the case with the arrowhead. Although well under water, several plants were seen with expanded, delicate, white petals. Since the flower stalks were only about a foot in height and the level of the lake does not fluctuate more than a few inches during the course of summer, it is apparent that the flowers had never reached the surface. It is uncertain what effect the water level had on the awlwort, which did bear unexpanded flower structures. In July, 1956, a few plants of the water lobelia were transplanted to shallow water where the scape was then emergent. The expected, pale-blue flowers appeared the next month. Flower buds on specimens in the original, deep-water habitat remained unopened. The following summer the mean water level lowered several inches and emergent scapes and expanded flowers were seen on the plants in this habitat.

DRUMMOND ISLAND

Drummond Island is also a formation of land situated in the St. Mary's River. The island, about 120 square miles in area, is located at the spot where the river flows into Lake Huron. Of any geographical unit within Chippewa County, this somewhat isolated part of the country has aroused the writer's interest the most. New county records of species are found on each visit to the island. The latest such records were found on June 3, 1961, when two rare species of sedge, *Carex concinna* and *C. richardsonii*, were collected. The Alaskan orchis, *Habenaria unalascensis*, was collected here in 1958.

One of the most unique of all the plant communities on Drummond Island is the limestone pavement. On the northern end of the island there are a few acres of relatively barren, mostly treeless, flat tableland or pavement of rock on which can be found many species that are infrequent or rare in the state, and probably are found nowhere else in the county. The soil is thin, or, in place, nonexistent. In such places the plants grow in crevices of the rock. In areas where there is some soil, the vegetation (mostly of grasses and sedges) forms a loose mat atop the flat rock surface. On one occasion, I was collecting here when a sudden cloudburst soaked the area. Racing toward shelter I experienced an odd sensation in that I felt as though I was on a shallow quaking bog. The rain had accumulated on the impervious rock surface and the mat of vegetation actually floated on the water.

The more conspicuous species of the pavement plant community are listed below:

Agropyron trachycaulum var. *novae-angliae*
Andropogon scoparius
Apocynum sibiricum var. *cordigerum*
Arenaria stricta
Aster pilosus var. *pringlei*
A. ptarmicoides
Bromus kalmii
Cardamine parviflora var. *arenicola*
Carex crawei
C. sartwellii
C. scirpoidea
Cerastium arvense
C. nutans
Cirsium hillii
Deschampsia cespitosa
Eleocharis compressa
Epilobium leptocarpum var. *macounii*
Geranium sphaerospermum
Juniperus horizontalis
Muhlenbergia glomerata
Ranunculus fascicularis
Rhus aromatica
Saxifraga virginiensis
Scutellaria parvula
Senecio pauperculus var. *balsamitae*
Sporobolus heterolepis
Trichostema brachiatum
Trisetum spicatum
Verbena simplex
Veronica peregrina var. *xalapensis*

In the summer of 1839, the first state geologist of Michigan, Douglass Houghton, explored Drummond Island and collected specimens of the wall-rue, *Asplenium ruta-muraria*, and the smooth cliff brake, *Pellaea glabella*. His specimens are on file at the University of Michigan herbarium; however, the labels with the specimens do not indicate the exact location from which the plants had been extracted (other than that they were from Drummond Island, Michigan, August 4, 1839). This lack of detailed information has frustrated botanists in their efforts to relocate these ferns which, incidentally, are rather rare in the state. From clues in Houghton's field notes, it appeared to me that the ferns might have been collected from a remote promontory on the eastern end of the island. After failing in three prior attempts to reach the area by land, I decided to try approaching it via the waterway along the coast. On September 1, 1961, I launched a boat with outboard motor from the southeast corner of the island and travelled northward five miles until I reached the promontory (locally known as Marblehead). It was a burnt-over cliff with vertical walls several feet high and facing the open water. I landed the boat on the rocky shore and climbed the talus slope to the base of the vertical cliff. The entire area reflected discouragement as it was very dry and with sparse, shrubby vegetation—an environment where one would hardly expect to find moisture loving ferns. Nevertheless, the reward came when a detailed search was made of the cliff. In small pockets and crevices were growing plants of both the wall-rue and the cliff brake. Both species were doing well, except that a few of the more exposed cliff brakes were suffering from drought. A few plants of the fragile fern, *Cystopteris fragilis*, and of the northern oak fern, *Gymnocarpium robertianum*, were also present. Further searches in more sheltered areas would have been desirable, but an impending storm necessitated a hasty retreat. However, by taking both specimens and pictures, I secured sufficient material to establish a record of the rediscovery of these rare ferns (Hiltunen, 1962).

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CHARACTERISTICS AND DISTRIBUTION OF THE SPRING CRESSES, *CARDAMINE BULBOSA* AND *C. DOUGLASSII*, IN MICHIGAN

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Cardamine bulbosa

Cardamine bulbosa (Muhl.) BSP. and *C. douglassii* Britt., two species of spring flowering Cruciferae, have caused confusion to plant taxonomists for years, as evidenced by various nomenclatural changes that the two entities have undergone. During 1961, I examined specimens in the herbaria of the University of Michigan, Michigan State University, and Cranbrook Institute of Science, and observed plants in their natural habitats in Ohio and Michigan to determine the diagnostic characters for the two species. As a result of this study, I consider them to be distinct, agreeing with Deam's *Flora of Indiana* (1940), Fernald's *Gray's Manual* (1950), and Gleason's *Illustrated Flora* (1952).

EXTERNAL MORPHOLOGY

Both species can be separated from other members of the genus by the presence of a short, perennial rhizome or tuber. In *C. bulbosa* this rhizome grows entirely just below the soil surface, whereas in *C. douglassii*, while the rhizome also grows beneath the soil surface, it may in addition be found growing on top of the ground. On these plants the rhizomes are dark green owing to the presence of chlorophyll in plastids. No external differences were noted in the roots which grow from the rhizome.

Since most of the herbarium specimens were immature plants before full elongation of the inflorescence, stem height was measured from the base of the plant to the lowest pedicel. This provided a less variable measurement of the height of the plants. Stem length in *C. douglassii* ranges from 1.0-2.5 dm.; and from 2.0-4.5 dm. in *C. bulbosa*. Continued growth of flowering plants would be expected to add from 0.5-1.0 dm. of additional length from the lowest pedicel to the tip of the raceme by the time the fruits mature. The stem of *C. bulbosa* often branches above, whereas the stem of *C. douglassii* seldom branches above.

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[1] This study was conducted while I held a first-year Rackham Graduate Fellowship at the University of Michigan.

Hopkins (1937) placed considerable importance on pubescence in separating various species of *Arabis*, a closely related genus. The length of the hairs and their location on the plant is also important in these two species. *C. bulbosa* is sometimes glabrous on all parts, but more often the stem is pilose from the base upward to as high as 8 cm. Other parts of the plant are glabrous with the exception of a few hairs on the edge of the cauline leaves. The hairs on the stem are short and soft, ranging from .08-0.18 mm. in length.

C. douglassii is glabrous on the lower 1 to 6 cm. of the stem. Higher up the stem, the plants are strongly pubescent, including the pedicels, sepals, and edges of the cauline leaves. Although sometimes sparse on the pedicels and sepals, these hairs are much longer than those of the other species, ranging from 0.2-0.8 mm. This character gives the best morphological basis for the separation of the two species.

Basal leaves of *C. douglassii* often have a red-purple cast to them owing to the presence of anthocyanin. This is especially noticeable on the underside of basal leaf blades. This red pigment is seldom expressed in *C. bulbosa*.

Fassett (1940) considered *C. bulbosa* to have basal leaves (technically blades) longer than wide, with *C. douglassii* having basal leaf blades as wide as long. After measurement of lengths and widths of basal leaf blades, as well as the lowest cauline leaf, in hopes of finding a length-width ratio difference, I conclude that the leaves are too variable to be used as a taxonomic character.

The use of basal leaves as a taxonomic character should also be avoided because they often die off before the plant flowers, or even if present, are sometimes not collected. Absence of basal leaves is more evident in *C. bulbosa* than in *C. douglassii*.

The number of cauline leaves varies within each species. *C. douglassii* has from 3 to 5 cauline leaves, and *C. bulbosa* has from 4 to 8 cauline leaves.

Petal color varies considerably in *C. douglassii*, from pure white to purple. However, petals are distinctly white in *C. bulbosa*. Hitchcock and Standley (1919) used sepal color to distinguish the two species in the District of Columbia. In our specimens it is a constant character. Sepals of *C. douglassii* are purple, becoming brown owing to aging, whereas *C. bulbosa* has green sepals that turn yellow upon aging.

Although the flowers of *C. bulbosa* are occasionally smaller, little significant difference was noted in our herbarium specimens. Petal length in C. *bulbosa* ranges from 6-12 mm. and width from 1-3 mm. In C. *douglassii* petals range from 8-12 mm. long and 1-3 mm. wide. Sepal length varies from 3-4 mm. long and 1-2 mm. wide in both species.

Of the material available, only a few specimens had mature fruit, so seeds and fruits were not studied. Deam (1940) considered the length of the pods and the length of their beaks too variable to be of taxonomic value. Murley (1951) concluded that no reliable differentiating characters could be found in the external morphology of the seeds.

Since fruiting material is very scarce in our herbaria, additional plants with mature fruits should be collected. The season for making collections of the plants in this condition is short because as soon as the pods and seeds become mature and dry, the pods snap open, dispersing the seeds. Therefore, collecting must be done just prior to complete maturation.

EXTREMELY HIRSUTE PLANTS

On plants which I collected in wooded ravines in Hocking and Hamilton Counties, Ohio, the stem, pedicels, sepals, basal leaf petioles, cauline leaf edges, and upper branches are covered with numerous short hairs, 0.03-0.08 mm. long. More material must be studied to determine whether this difference in pubescence constitutes importance for recognizing an entity of infraspecific rank. These plants may only represent an ecological form.

Deam (1940) has suggested that extremely pubescent plants (most likely referring to the above type) may be albino forms of C. *douglassii* This is very unlikely, because the above pubescent plants have all the other characteristics of typical C. *bulbosa.* These plants agree in flowering time, flower and sepal color, number of cauline leaves, stem height, branching above, and smaller petals. The stem pubescence appears like that which is found at the base of typical C. *bulbosa,* only shorter in length.

The flowering period of these hirsute plants is later than the flowering period of C. *douglassii.* A collection made of both species growing together in the same site in Hamilton County, Ohio, supports this. The hirsute plants were in young bud, whereas C. *douglassii* was in flower and young fruit. As mentioned in the nomenclatural discussion below, an albino form described by Farwell agrees in every respect with the typical C. *douglassii,* including flowering period. Thus, Farwell's epithet should not be applied to the hirsute plants described above.

FIELD OBSERVATIONS

Eight sites in Ohio and Michigan were visited during the 1961 spring season. The habitats encountered were primarily low wet woodlands. C. *douglassii* was usually found where the trees were more dense in the low areas of the woods. The most common associated herbaceous plants flowering at this time were *Claytonia virginica, Erythronium americanum, Dentaria laciniata, Viola papilionacea,* and *Asarum canadense.* Although the plants may be found growing in shallow water in early April, this condition does not persist, and so by May, the plants may be found in what appear to be drier areas. For the most part the habitat of this species is drier than that of *C. bulbosa,* which is usually located in the wet and muddy portions of the woods. *C. bulbosa* may be found growing in water during May. Often it is found on banks of streams and in areas where trees have been cleared. The most common associated plants are *Caltha palustris, Symplocarpus foetidus, Ranunculus septentrionalis* and *Onoclea sensibilis.*

In Washtenaw County, Michigan, the flowering periods of these species occurred at two different peaks in 1961. *C. douglassii* was in flower from April 10 to May 15, and *C. bulbosa* flowered from May 10 to June 15. A slight overlap occurred in mid-May. The duration of this overlap varies depending upon the geographical location, local weather conditions, and the particular season.

HYDRIDIZATION

Hydridization has been suggested as a reason for the difficulty in separating the two species (Zenkert, 1934). Special notice was given to this aspect when the plants were observed in the field. In five of the eight habitats visited, both species were growing together. In these locations, no plants appearing to be intermediate between the two species were found except two individuals which were collected May 13 in a woods located in Section 19, Pittsfield Township, on the east side of Maple Road between Ellsworth and Textile Roads, in Washtenaw County, Michigan.

These two plants had a slightly different appearance from the other surrounding individuals in this woods. They were pale green with small white petals tinged with purple, 5-8 mm. long, most of which were still on the plant, indicating an intermediate flowering condition, compared to *C. douglassii,* which had a few remaining flowers, and to a few *C. bulbosa,* which had one or two flowers.

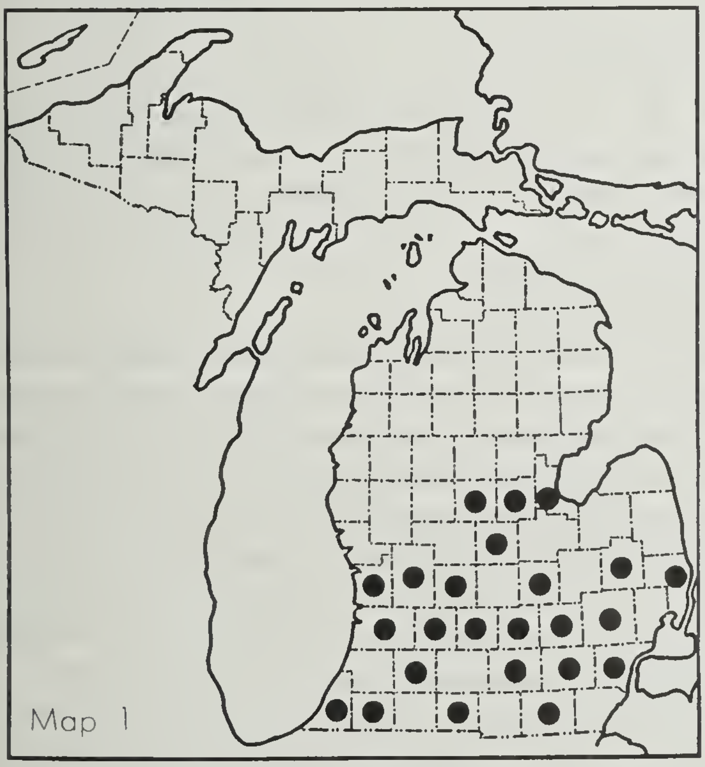
The four cauline leaves on each of these plants resemble those of *C. bulbosa,* but are slightly smaller with margins nearly entire. The pubescence gives the plants the appearance of *C. douglassii,* but the hairs range from 0.16 to 0.40 mm. long, a length intermediate between the two species. Only a few hairs are on the pedicels, sepals, and upper portion of the stem. The center of the sepals is green-yellow surrounded by a purple tinge and an outer white margin. The heights of the stems to the lowest pedicel are 1.85 and 1.45 dm. In comparison with other plants of both species in the population the anthers of these two plants were poorly developed and only a few pollen grains were produced, some of which appeared irregularly shaped. These two plants (Stuckey 462, MICH) could probably pass as *C. douglassii,* but since the location and conditions under which they occurred are known, the possibility of a hybrid seems more likely. A search for similar appearing plants in other localities where both species grow together would prove interesting. If such plants are found, cytological studies might provide additional evidence to confirm hybridization.

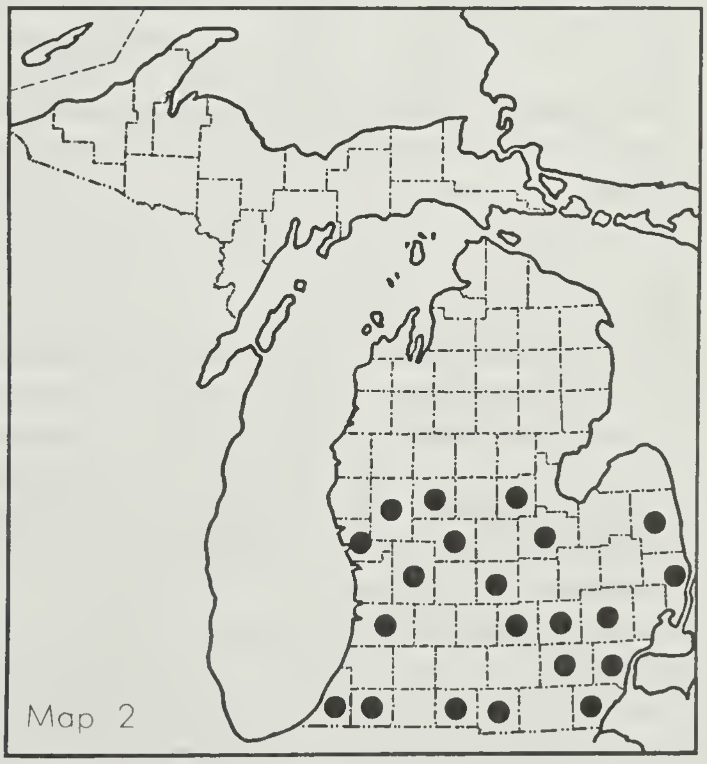
The most significant evidence against hybridization occurring between these two species is that they reach their peak in flowering at two different periods in the spring. Hybridization and introgression leading to a breakdown in the distinction between the two species, to an extent that they can not be distinguished, is apparently occurring very rarely if at all. Although each is variable within itself, the two species can be readily distinguished in their natural habitats. Morphological distinctions, as outlined above, are present if one looks more carefully.

GEOGRAPHICAL DISTRIBUTION

Both species are limited to eastern United States and southern Canada. According to Fernald (1950) and Gleason (1952), *C. bulbosa* ranges from New Hampshire across southern Quebec to Minnesota and Kansas, southward to Texas and northern Florida. *C. douglassii* occurs from Connecticut and southern Ontario to Wisconsin and southward to Missouri, Tennessee, and Virginia.

Michigan lies along the border of the northern range for both species, which are limited to the southern portion of the Lower Peninsula. County distribution maps based on specimens in the herbaria of the University of Michigan, Michigan State University, and Cranbrook Institute of Science are given (maps 1 and 2). A few additional county records listed by Walpole (1927) have been unsubstantiated by specimens. Both species are known from Kalamazoo County (Hanes and Hanes, 1947).





Map 1. County distribution of *Cardamine douglassii* in Michigan.

Map 2. County distribution of *Cardamine bulbosa* in Michigan.

Further collecting should add additional county records in the southern portion of the state and may add additional records along the northern range for both species.

NOMENCLATURAL HISTORY

The species that is now known as *Cardamine bulbosa* was originally validly published as *Arabis bulbosa* by Muhlenberg (1793), in which he referred to a description of a plant collected by John Clayton and described by Gronovius (1762). This name was suggested by Schreber in a letter to Muhlenberg. According to article 46 of the ''International Code of Botanical Nomenclature'' (1956), Muhlenberg should be cited as the original author of the species epithet rather than Schreber, as has usually been done. The species was later transferred to the genus *Cardamine* by Britton, Sterns, and Poggenburg (1888).

Schulz (1903) considered *Arabis bulbosa* of Muhlenberg (1793) as a *nomen nudum*. Apparently Schulz failed to check Gronovius' original description. He used the name *Cardamine rhomboidea* (Pers.) DC., which was based on descriptions after 1793.

Cardamine douglassii was first published as a new species by Britton (1889), based on *Arabis rhomboidea* var. *purpurea* of Torrey (1822). Later Torrey (1838) had published the name *Arabis douglassii,* but as a synonym. Because names published in synonomy are invalid (article 37), Torrey should be omitted from the author citation.

Still later, *Cardamine purpurea* was published as a name for this species (Britton and Brown, 1897). Apparently they raised the original varietal epithet, *purpurea,* to species rank. This was illegitimate not only because the name *C. douglassii* was already available for this species, but also because *C. purpurea* was used previously for a different species described from northwestern North America. Authors citing this species, *C. purpurea* Cham. & Schlecht., as a synonym for *C. douglassii* Britt., are in error (cf. Vogt, 1914).

EVALUATION OF VARIETIES AND FORMS

Schulz (1903) described four varieties and three forms under *C. rhomboidea;* varieties *pilosa, hirsuta, parviflora,* and *grandiflora,* and forms *integrifolia, angustifolia,* and *microphylla* all belong to what is now called *C. bulbosa*; while a fourth form, *C. rhomboidea* f. *purpurea,* is equivalent to *A. rhomboidea* var. *purpurea* Torr., which is now known as *C. douglassii* , as pointed out above. Schulz's varieties and forms were primarily based on minor morphological variations. Many Michigan specimens of *C. bulbosa* can be referred to his variety *pilosa,* which he described as having the stem base and leaf margin pilose. In variety *hirsuta,* the entire stem, leaf margins, pedicels, and sepals are hirsute. This description fits the plants which I collected in southern Ohio. His remaining varieties and forms are based on minor leaf variations, probably caused by the environment, and need not be further discussed.

C. douglassii f. *albidula* (Farwell, 1925) is a white flowered form described from Alexis, Ohio, near the Ohio-Michigan border. After observing populations of *C. douglassii* in the field, I believe that the white flowered form can not be separated from the common purple ones. Color variation ranges from white to pink to purple. Some of the early flowering plants were deep purple. Perhaps fading occurs as the season progresses. After examination of an isotype of *C. douglassii* f. *albidula,* I conclude that all of the significant characters—pubescence, stem height, sepal color, and number of cauline leaves—are like those of the typical *C. douglassii.* A taxonomic form based only on flower color is meaningless in this species. As mentioned earlier, the white flowered hirsute plants from southern Ohio, apparently the ''var. *hirsuta*'' of Schulz, agree in all other characteristics with typical *C. bulbosa.* Thus, *C. rhomboidea* (Pers.) DC. var. *hirsuta* Schulz is not equivalent to *C. douglassii* Britt. f. *albidula* Farw.

No Michigan specimens were found to belong to *C. bulbosa* f. *fontinalis*, a form described by Palmer and Steyermark (1938) from the Ozark Mountains of Missouri.

SUMMARY

Cardamine bulbosa (Muhl.) BSP. and *C. douglassii* Britt., two spring flowering species of Cruciferae, can be separated from other members of the genus by a bulbous, perennial rhizome. Distinguishing characters separating the two species in this region are summarized, in order of their importance, in the following table:

TABLE I. Comparison of the Distinguishing Characters of *Cardamine douglassii* and *Cardamine bulbosa* in Michigan.

Character	*Cardamine douglassii*	*Cardamine bulbosa*
Flowering Period (seasons vary)	Early spring April 10 to May 15	Late spring May 10 to June 15
Pubescence	Hairs long (0.2-0.8 mm.), on stem, pedicels, and sepals	Hairs short (0.08-.18 mm.), if present, at base only
Sepals	Purple-brown with white margins	Green-yellow with white margins
Branching Above	Seldom	Often
Number Cauline Leaves	3 to 5	4 to 8
Height to Lowest Pedicel	Short (1.0-2.5 dm.)	Tall (2.0-4.5 dm.)
Flower Color	White, Pink, Purple	White
Habitat	Drier areas in dense woods	Wetter areas in open woods

ACKNOWLEDGEMENTS

I wish to thank Dr. Edward G. Voss for his advice during this study, especially the help with the nomenclatural history, and Dr. William Randolph Taylor for the photograph of *C. bulbosa.*

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SEASONAL ASPECTS OF BERCHTOLD'S PONDWEED

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During type-mapping of aquatic plants, an interesting series of observations were made regarding Berchtold's pondweed (*Potamogeton berchtoldi* Fieber), demonstrating spectacular seasonal changes in abundance. In July, 1953, large and tangled masses of this pondweed were noted floating downstream on the surface of the lower Detroit River in the vincinity of Grosse Isle in southeastern Michigan. Windrows of the plant were found along the shores of the river. Portions of the floating and windrowed masses were green and apparently living, even though detached from the substrate. In a matter of a few days all of this material had disintegrated and was unidentifiable. The large areas of river shallows where Berchtold's pondweed had flourished rooted to the substrate were now free of it and in its place wild celery (*Vallisneria americana* Michx.) and, to some extent, sago pondweed (*P. pectinatus* L.) were found.

During the summer of 1954 a close watch was kept on the seasonal vegetation changes. Mapping and sampling work was started June 25, 1954, at which time Berchtold's pondweed was fully grown and in bloom. A search below the water surface in the dense beds of this pondweed, which extended over large areas, revealed other aquatic plants, among which was wild celery. By July 15, 1954, Berchtold's pondweed had withdrawn from the water surface, masses had detached from the bottom and were floating off, and some of the plants had disintegrated while still attached to the substrate. By July 30, 1954, the once vast amount of this species was gone and had been replaced by well developed stands of wild celery and other aquatic plants.

The same sequence of events occurred in 1955. Full growth and blooming of Berchtold's pondweed were evident by July 1, it began disintegrating and floating off by July 12, and on July 27 there was none remaining. The other aquatic plants were abundant by the latter date.

Bellrose & Anderson (1943) noted similar disintegration of small pondweed (*P. pusillus* L.) after fruiting time in late July and early August. Their observations were made in the Illinois River valley.

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[1] I appreciate the assistance given to me by the Game Division, Michigan Department of Conservation. This report is based on my doctoral dissertation submitted to The University of Michigan in June, 1957.

Michigan Botanists—Past and Present

Florence N. Hanes, co-author with her late husband, Clarence, of the excellent *Flora of Kalamazoo County, Michigan* (1947), received an honorary doctor's degree from Western Michigan University, Kalamazoo, on June 10, 1961.

Eugene C. Ogden, State Botanist of New York, at the New York State Museum, Albany, plans to spend May in Texas, collecting aquatics in preparation for writing up the Najadaceae of that state. Dr. Ogden, the leading authority on aquatic vascular plants, is a 1932 graduate of Michigan State University and a native of this state.

F. J. Hermann left his job at Beltsville last summer to become Director of the U. S. Forest Service Herbarium, in Washington. Dr. Hermann, whose paper on "The Genus Carex in Michigan" is one of the finest contributions yet published on the flora of the state, is a native of the Upper Peninsula and graduated in 1928 from the University of Michigan, from which he received his Ph.D. in 1938.

Gwen Frostic, of Frankfort, Michigan, whose "Presscraft Note Papers" display her artistic skill with our wild plants and birds, has bought a farm on both sides of the Betsie River, where she has found many variants of trilliums. Mrs. Frostic, a member of the Northwestern Chapter of the Michigan Botanical Club, has invited the chapter to spend the day there in the spring.

Michigan Botanists—Future

The Northwestern Chapter reports that their junior members "'are well on the way to becoming good future botanists and adult club members'." Activities of their junior members might provide some ideas for other groups. A campout for juniors only was held at Marjorie Votey's in July. Katy Rehkopf gave a talk on how ferns produce spores, and displayed a life cycle chart she had made. John Russell showed wildflower slides for a guessing game. A pancake breakfast fortified all for a field trip the next day to collect fern fronds.

In August, they gathered to mount the ferns in artistic books, under the direction of Aletheia Brown. The junior members, under the chairmanship of Margaret Russell, had charge of the regular meeting on November 17, when prizes (MBC embroidered emblems) were awarded to Carol Votey and Carol Doyle for the best fern books.

Herbarium at the Ford Forestry Center

A herbarium has been established as part of the research facilities at the Ford Forestry Center, located about eight miles south of L'Anse, in Baraga County. The Center is a forestry research division of the Michigan College of Mining and Technology, whose main campus is at Houghton. The herbarium includes approximately 5000 specimens, representing some 1900 species, the majority of which are northern plants. The list for Baraga County now stands at approximately 600 species. Only one is new to Michigan: *Stenanthium gramineum* (featherbells) is well established along highway M-35 at the Baraga-Houghton county line some 500 miles north of its natural range.

The Center's herbarium is available to any qualified person who wishes to use it. In order to extend the usefulness of the collection, the Center will welcome duplicates from other herbaria and will exchange specimens with interested persons or agencies.

—Eric A. Bourdo, Jr., Director

CORTICOLOUS BRYOPHYTE AND LICHEN COMMUNITIES ON AMERICAN BEECH (*FAGUS GRANDIFOLIA*) IN NORTHERN MICHIGAN[1]

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Increasing attention is being given to bryophyte and lichen vegetation on tree trunks from the standpoint of their phytosociological relations. Observations and collections for a study of the corticolous bryophytes and lichens on American beech (*Fagus grandifolia* Ehrh.) in a northern hardwood forest were made on a botanical foray with W.S. Benninghoff and his ecology class from the University of Michigan Biological Station, August 8, 1961.

Sixteen relevés (lists of all species with estimates of their cover and sociability on sample plots) were taken on beech trunks in an old age, over-mature northern hardwood-mixed conifer stand near Tahquamenon Falls (T48N, R8W, Section 1, N 1/2- SW 1/4, Luce County, Michigan). The stand was dominated by beech, hemlock *(Tsuga canadensis)*, and yellow birch *(Betula lutea)*.

The stand is 300-350 years old (based on increment core analysis of Cedar 300+ and 307+ and Hemlock 305+ and 312 years old at DBH), with trees 20-30 meters in height having a crown closure of 80%. Cover in the shrub, herb, and ground (bryophyte and lichen) strata was 20%, 50%, and 20%, respectively.

METHODS

A modification of the Zurich-Montpellier method of survey was used (see Bevis, 1960). Cover values, the first figure for a species in the tables, are: 5 equals 76-100% of the area covered, 4 is 51-75%, 3 is 26-50%, 2 is 6-25%, 1 is less than 5% cover, + is less than 1%, and r has only presence value. The second number in each estimate refers to sociability (gregariousness): 5 indicates plants in pure populations; 4, plants in patches or small colonies; 3, plants in little groups or cushions; 2, plants in small tufts; 1, plants growing singly. For example, the estimate 3.5 fr (see *Neckera pennata*, Table 1, Tree No. 2) indicates 26-50% cover, in pure populations, and in fruit (with capsules). No sociability is assigned to plants of cover value + or r. Moisture rank of bark and bark ridges was estimated as follows: 1, dry; 2, fresh; 3, moist; 4, wet; and 5, spongy.

Trees were selected for sampling on the basis of differences in DBH, bark configuration, exposure, and presence of bryophyte or lichen cover. All trees were sampled between 1.2 and 1.8 meters on the trunk on two sides, and also at the bases of trees 1 through 4. The position of highest cover for all species present was designated the center of the relevé, and the plot was extended around the trunk until a visible decrease in cover and number of species present was noted. A companion relevé was taken on the opposite exposure in each instance (see tables 1 and 2). Exposure (N,S,E,W), general bark configuration and moisture, ridge and crack depth and moisture, total plant cover, and cover and sociability of each species present were recorded. Data concerning the nature of the bark, exposure, total plant cover, and plot size are presented in the table headings.

Various references were used for the identification of lichens (Fink, 1935; Hale, 1961; Luttrell, 1954; and Nearing, 1947), but all nomenclature follows Hale and Culberson (1960). Schuster (1953-1958) was followed for the naming of liverworts, while Grout (1928-1940), Jennings (1951), and Welch (1957) were used for the mosses.

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[1] Partial support for this study was provided by National Science Foundation Grant G-5578, "Phytosociological Survey in Michigan," W. S. Benninghoff, principal investigator.

		Parmelia-Dimerella Union				Amblystegiella-Pertusaria Union	
	TREE NUMBER	1	2	3	4	5	6
	DBH (Inches)[1]	24.6	20.7	18.7	15.8	24.2	16.8
	EXPOSURE	E-N	W-E	E-NE	E	E-NE	N-NE
	PLOT SIZE (m^2)	0.32	0.32	0.16	0.16	0.32	0.16
	HEIGHT ABOVE GROUND (m)	1.4-1.8	1.4-1.8	1.2-1.6	1.4-1.8	1.4-1.8	1.2-1.6
	BARK MOISTURE	1-2	1-2	1-2	1	1-2	1
	BARK CONFIGURATION[2]	Ro,L,Ri,D	Ro,L,Ri,D	T,S,C	T,S,C	T,S,D,Ri	T,S,Ri
	RIDGE DEPTH (cm)	0.6-1.9	0.6-1.6	0.5-0.9	0.4-0.7	0.2-1.4	0.2-0.6
	RIDGE MOISTURE	2-3	3	1-2	1	3-4	3-4
SPECIES	TOTAL PLANT COVER (%)	85	75	80	65	85	60
Lecanora subfusca (L.) Ach.		2.3	1.3	3.4	1.3	3.5	2.4
*Neckera pennata Hedw.		2.4fr	3.5fr	1.2fr	2.3fr	r	+
Parmelia cetrarioides (Del. ex Duby) Nyl.		3.4	2.4	3.4	2.4	+	+
*Ulota crispa (Hedw.) Brid.		1.4fr	1.4fr	+	r	2.4fr	1.3fr
Lobaria pulmonaria (L.) Hoffm.		1.4	1.4	r	+	r	1.3
*Frullania eboracensis Gottsche		1.2	1.2	2.2	+	1.2	+
*Radula complanata (L.) Dumort.		+	r	r	+	1.4	+
Parmelia rudecta Ach.		3.4	3.5	1.3	2.4		
Parmelia aurulenta Tuck.		3.4	2.4	3.4	1.3		
Lobaria quercizans Michx.		1.4	1.4	+	1.3	+	
Dimerella lutea (Dicks.) Trev.		1.3	+	1.4	+		
Graphis scripta (L.) Ach.		+	r	1.3	2.3		r
Bacidia schweinitzii (Tuck.) Schneid.		1.3	+	+			
Anaptychia speciosa (Wulf.) Mass.		+	r				
*Hypnum reptile Michx.		+					
Pertusaria multipuncta (Turn.) Nyl.			+	+		3.4	3.4
*Amblystegiella subtilis (Hedw.) Loeske						3.5	2.4
*Platygyrium repens (Brid.) B.S.G.						1.4	+

[1] DBH (Diameter of the trunk at 4.5 feet above the ground).

[2] Ro (Rough); Ri (Ridged); C (Cracked); T (Tight); S (Smooth); and D (Decaying).

Table 1. Corticolous bryophyte and lichen communities on east exposures of trunks of American Beech. Tree numbers correspond to those in Tables 2 and 3. All bryophytes (liverworts and mosses) are indicated by an asterisk (*). Boxes around groups of species denote those characteristic of the Union.

DESCRIPTIONS OF CORTICOLOUS COMMUNITIES

Investigations concerning the bryophyte and lichen vegetation occurring on trunks of trees has received considerable attention in European ecology and phytosociology and has been extensively reviewed in Barkman, *Phytosociology and Ecology of Cryptogamic Epiphytes* (1958). Early studies on the ecology of corticolous communities in North America were sporadic, with only a few exploratory publications resulting (Billings and Drew, 1938; Cain and Sharp, 1938; Raup, 1930; and Wilson, 1936). Recently Brodo (1961), Brown (1948), Coleman, et al. (1956), Culberson (1955, 1958), Hale (1950, 1952, 1955), Phillips (1951), and Quarterman (1949) have published concerning corticolous communities. The European work treating communities on beech (*Fagus sylvatica* L., of

Europe) is discussed in Barkman (1958). Studies of communities on the American beech have been made by LeBlanc (1960) in Quebec, Hale (1950) in Connecticut, Culberson (1955) in Wisconsin, Brown (1948) in New York, Cain and Sharp (1938) and Billings and Drew (1938) in the Great Smoky Mountains.

Cain and Sharp (1938) described 5 communities occurring on trunks and bases of beech: the *Neckera pennata* Union, the *Dicranum fulvum* Union, and the *Ulota crispa* Union, the last represented by three facies characterized by *Leucodon brachypus, Anomodon rugelii,* and *Ulota americana.* These communities were on trunks and bases of beech from ground level to approximately 2 meters. Billings and Drew (1938) list 8 communities on trunks of trees in eastern Tennessee, of which 4 were on beech: the *Neckera pennata* Union, the *Anomodon attenuatus* Union (only the *A. rugelii* facies on beech), the *Brachythecium oxycladon* Union, and the *Hylocomium brevirostre* Union. LeBlanc (1960) reports 8 unions on beech in southern Quebec, characterized by *Hypnum reptile, Dicranum montanum* (with the *Plagiothecium denticulatum* and the *Heterophyllium haldanianum* facies), *Platygyrium repens, Neckera pennata, Bacidia chlorococca, Graphis scripta,* and *Parmelia rudecta.*

Culberson (1955) reported 30 lichens and 10 bryophytes on beech, with an average of 3.7 species per tree trunk. The most frequent species were *Lepraria aeruginosa* (Wigg.) Sm. (69%), *Graphis scripta* (L) Ach. (57%), *Trypethelium virens* Tuck. (30%), and *Physcia orbicularis* (Neck.) DR. (27%). In this study, only *Graphis scripta* was found, although the others are common on beech trunks in the vicinity of Cross Village, Emmet County, in the northern Lower Peninsula of Michigan. Species listed by Culberson common to this study are *Parmelia rudecta* Ach. (20%), *Platygyrium repens* (Brid.) B.S.G. (18%), *Frullania eboracensis* Gottsche (14%), *Parmelia aurulenta* Tuck. (7%), *Lecanora subfusca* (L.) Ach. (6%), *Ulota crispa* (Hedw.) Brid. (4%), *Neckera pennata* Hedw. (2%), and *Dicranum montanum* Hedw. (1%).

RESULTS

Three communities were found on beech trunks near Tahquamenon Falls (Tables 1 and 2): the *Parmelia aurulenta-Dimerella lutea* Union, the *Amblystegiella subtilis-Pertusaria multipuncta* Union, and the *Frullania eboracensis* Union. Two communities were found at the base and over exposed roots of beech (Table 3): the *Brachythecium oxycladon* Union and the *Hypnum reptile* Union.

A. Lecanora subfusca-Parmelia cetrarioides Group:

Union of Parmelia aurulenta-Dimerella lutea (Table 1). This community is characteristic of dry, decaying, loose, and rough bark, and is possibly related to the *Parmelia rudecta* Union described by LeBlanc (1960), although there are few species in common.

Union of Amblystegiella subtilis-Pertusaria multipuncta (Table 1). This community is frequent on tight, smooth bark with shallow ridges or cracks. Although *Platygyrium repens* is present, this community does not appear to be related to the one named by LeBlanc (1960). Both this and the preceeding community were confined to the east exposures of well illuminated, dry bark and apparently are variations of a community characterized by *Lecanora subfusca* and *Parmelia cetrarioides.* This group has not been previously reported in the literature.

Union of Frullania eboracensis (Table 2). This community is characteristic of very dry, smooth bark and usually has few species. There is close agreement between this union and the *Frullania* facies of LeBlanc's (1960) *Platygyrium repens* Union. It was also common on smooth bark of young red maple and yellow birch in the Tahquamenon Falls area. *Frullania* was present in all relevés of the *Lecanora* group.

		Frullania eboracensis Union					
	TREE NUMBER	1	2	3	4	5	6
	DBH (Inches)	24.6	20.7	18.7	15.8	24.2	16.8
	EXPOSURE	W-SW	W-SW	W-SW	W	W-SW	W-SW
	PLOT SIZE (m^2)	0.16	0.16	0.16	0.16	0.16	0.16
	HEIGHT ABOVE GROUND (m)	1.2-1.6	1.3-1.7	1.4-1.8	12-1.6	1.4-1.8	1.4-1.8
	BARK MOISTURE	1-2	1-2	1	1-2	1-2	1
	BARK CONFIGURATION	L,S,Ri	L,S,Ri	L,S,Ri	T,S,C	T,S,C	T,S,C
	RIDGE DEPTH (cm)	0.1-0.4	0.2-0.7	0.3-0.6	0.1-0.3	0.1-0.3	0.2-0.5
SPECIES	TOTAL PLANT COVER (%)	20	15	35	10	20	10
*Frullania eboracensis Gottsche		2.3	2.3	3.3	1.3	2.3	1.2
*Platygyrium repens (Brid.) B.S.G.			+	+	+		+
Lecanora subfusca (L.) Ach.		+	+	+		r	
Parmelia aurulenta Tuck.		r		1.3	+		
Graphis scripta (L.) Ach.		+			r		
*Neckera pennata Hedw.		r	r				
Pertusaria multipuncta (Turn.) Nyl.						1.3	+
*Ulota crispa (Hedw.) Brid.		+fr		1.3fr			
*Radula complanata (L.) Dumort.		r					

Table 2. Corticolous bryophyte and lichen communities on west exposures of trunks of American Beech. Tree numbers correspond to those in Tables 1 and 3. All bryophytes (liverworts and mosses) are indicated by an asterisk (*).

(Union of Ulota crispa). *Ulota crispa,* confined to moist ridges and well illuminated trunks, possibly could be used to distinguish a separate community as was done by Cain and Sharp (1938).

B. Brachythecium-Campylium-Hypnum Group:

Union of Brachythecium oxycladon (Table 3). This community is common on moist to wet, decaying, loose, and rough bark at the bases of beech trees. It was also noted on a large yellow birch stump and over decaying logs Apparently, the community is closely related to the union of the same name described by Billings and Drew (1938).

Union of Hypnum reptile (Table 3). This community occurs widely on tight, smooth, dry to fresh bark of exposed roots and at the bases of beech, hemlock, and balsam fir. There is general agreement with the *Hypnum reptile* Union of LeBlanc (1960).

Different illumination levels (not studied), bark configuration and moisture, position on the tree (base or trunk), and exposure are environmental factors coincident with the distribution of corticolous communities on American beech. Raup (1930) concluded that age of the tree, the roughness of the bark, and exposure on the trunk were the major factors accounting for the development of lichen associations on white spruce *(Picea glauca)*. Schuster (1949, 1953-1958) came to similar conclusions in studies of corticolous liverworts, and Culberson (1955) considered factors of the bark substrate most important. Billings and Drew (1938) found bark moisture and maturity to be important in bryophyte community development on tree trunks, while Hale (1950) considered bark configuration critical to lichen communities.

The *Lecanora subfusca-Parmelia cetrarioides* community and its variations are apparently newly reported for beech trunks. The other communities described, in general, can be compared with some previously reported in the literature.

		Brachythecium oxycladon Union			Hypnum Union
	TREE NUMBER	1	2	3	4
	DBH (Inches)	24.6	20.7	18.7	15.8
	EXPOSURE	E-N	E	E-W	NE-E
	PLOT SIZE (m^2)	0.32	0.32	0.32	0.32
	HEIGHT ABOVE GROUND (m)	- - -Ground to 0.4 meters- - -			
	BARK MOISTURE	4	3-4	3	2-3
	BARK CONFIGURATION	T,Ro,Ri,D		T,Ro	T,S
	RIDGE DEPTH (cm)	0.9-3.4	0.5-1.9	0.5-1.3	0.4-0.6
SPECIES	TOTAL PLANT COVER (%)	75	85	60	80[2]
*Campylium hispidulum (Brid.) Mitt.		3.4fr	4.5fr	3.5fr	+
*Brachythecium salebrosum (Web. & Mohr) B.S.G.		3.4fr	+fr	1.2fr	+fr
*Brachythecium oxycladon (Brid.) Jaegr. & Sauerb.		1.3fr	+fr	+fr	
*Brachythecium salebrosum/oxycladon[1]		2.3	1.3	1.3	
*Hypnum reptile Michx.		+	2.4	+	4.5fr
*Ptilidium pulcherrimum (Web.) Hampe			r		1.3
Lobaria pulmonaria (L.) Hoffm.		+			
*Neckera pennata Hedw.				+	
Parmelia aurulenta Tuck.				r	
*Dicranum montanum Hedw.		1.3	+		

[1] Sterile material, not able to separate.

[2] *Dicranum scoparium Hedw. (1.4fr), *Diphyscium foliosum Mohr. (+fr), Cladonia chlorophaea (Flörke) Spreng. (r), and Cladonia macilenta Hoffm. (+) were on thin, clay loam over an exposed root.

Table 3. Corticolous bryophyte and lichen communities on east exposures at the base and over exposed roots of American Beech. Tree numbers correspond to those in Tables 1 and 2. All bryophytes (liverworts and mosses) are indicated by an asterisk (*). Boxes around groups of species denote those characteristic of the Union.

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MICHIGAN PLANTS IN PRINT

It will be our intention to include regularly in this section annotated lists of literature relating to Michigan plant life. It is hoped that these will be of use to schools and libraries as well as to individuals. Two general divisions will be continuing features: "Guide to Literature on the Michigan Flora" and "New Literature Relating to Michigan Botany." Neither can be complete, but both will attempt to cover the items believed to be of most value and interest to our readers. We will appreciate having our attention called to items which should be included. When prices are indicated, they are understood to be the current prices of books in print, but the editors cannot assume responsibility for perfect accuracy. The Michigan Botanical Club does not operate a mail-order book service. Books may be ordered through your local bookstore or from the Michigan Audubon Society Book Shop, c/o Kalamazoo College, Kalamazoo, Michigan.

— E. G. V.

Guide to Literature on the Michigan Flora

Under this subject will be treated books, bulletins, and journal articles relating to the flora of Michigan, more or less regardless of date of publication but with emphasis on recent literature. A tentative listing of the categories which are planned for this and successive issues appears below. These are basically floristic in nature; the literature on such areas of botany as ecology and forestry is large and somewhat less susceptible to organization into distinct categories. We hope to include material on these aspects later. (New publications of significance in these areas will, however, be included regularly in the listings of "New Literature.")

1. Basic regional literature (not specifically pertaining to Michigan).
2. Guides and manuals specifically for Michigan vascular plants.
3. Local lists for regions of the state (vascular plants).
4. Guides and lists ("lower plants").
5. Information *about* the flora (bibliographies, herbaria, etc.)
6. Useful works on certain families and genera (not Michigan-oriented).
7. Useful manuals for other regions.

1. BASIC REGIONAL LITERATURE

The works listed here *do not specifically pertain to Michigan,* but our state is either included in the area covered or is adjacent or near it (in the case of certain outstanding regional publications).

A. STANDARD MANUALS.

Fernald, Merritt Lyndon. 1950. Gray's Manual of Botany. 8th ed. Am. Book Co., New York. lxiv + 1632 pp. [The standard one-volume manual for the northeastern U.S. and adjacent Canada, with keys, concise descriptions, and numerous illustrations of details. Often considered rather technical by those not previously exposed to botanical manuals, but widely accepted as the ultimate authority. $15.00]

Gleason, Henry A. 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. [N.Y. Bot. Gard., New York.] 3 vol. [Three large volumes, fully illustrated with line drawings, covering essentially the same area as Gray's Manual, with keys and descriptions. The keys are often considered less difficult than those of Fernald. $35.00. A "short version" of this work, in one volume, by A. J. Cronquist, will include the keys and brief descriptions, and is expected to be published this spring.]

Fassett, Norman C. 1957. A Manual of Aquatic Plants. With revision appendix by Eugene C. Ogden. Univ. Wisconsin Press, Madison. 405 pp. [An excellent, illustrated set of keys to vascular plants of fresh water, exclusive of bogs, in the northeastern U.S.; vegetative characteristics are emphasized. $6.50]

Wherry, Edgar T. 1961. The Fern Guide. Doubleday & Co., Garden City, N.Y. 318 pp. [A guide of excellent quality to Pteridophytes of the northeastern states, with keys, descriptions, and precise habitat notes by an author with wide field experience; the book is illustrated by very good line drawings but not, contrary to statements on the dust jacket, by either color illustrations or photographs. $3.95]

B. OUTSTANDING WORKS ON NEIGHBORING REGIONS.

Braun, E. Lucy. 1961. The Woody Plants of Ohio. Ohio State Univ. Press, Columbus. 362 pp. [An excellent new work on trees and shrubs, with keys, unusually good line drawings, and distribution maps (for Ohio); should be very useful in southern Michigan. $7.50]

Deam, Charles C. 1953. Trees of Indiana. 3rd rev. ed. Indiana Dept. Conservation, [Indianapolis 9] . 330 pp. [Another outstanding regional work on trees, out of many which could be cited. Original keys and descriptions, photographs of specimens, and maps (for Indiana). $3.50]

Deam, Charles C. 1940. Flora of Indiana. Indiana Dept. Conservation, [Indianapolis] . 1236 pp. [Now out of print and extremely rare on the secondhand market; but one of the finest examples of a state flora ever published, and the only one for any state bordering on Michigan. Unusually ample and original keys; distribution maps (Indiana).]

Fassett, Norman C. 1957. Spring Flora of Wisconsin. 3rd ed. with revisions by Margaret S. Bergseng. Univ. of Wisconsin Press, Madison. 189 pp. [A truly pocket-sized guide to the plants which bloom in Wisconsin before June 15, and almost equally serviceable in Michigan. Brief but very good keys and copious drawings—a strongly recommended little book. $2.50]

C. WILD FLOWERS.

This is a category under which it is dangerous even to begin what could be a nearly endless list. Wildflower books are numerous, some of them are good, many are quite poor. One ought to examine such a volume carefully before adding it to his library. One basic problem is that the author's selection of species to include often does not cover the species you want to identify. (All of the books previously listed aim to be complete within the announced limitations of their geographic, taxonomic, and seasonal scope.) Mathews' fieldbook has long been one of the best pocket-sized books, with accurate and artistic drawings, and we will stop with listing it. For some years we have been looking forward to the promised publication of a field guide to wildflowers by Margaret McKenny and Roger Tory Peterson, in the famous Peterson Field Guide Series (Houghton Mifflin).

Mathews, F. Schuyler. 1955. Field Book of American Wild Flowers. Rev. and enlarged by Norman Taylor. Putnam's, New York. 601 pp. [$5.00]

D. LOWER PLANTS.

Listed first are four works which aim to be complete for the areas covered. There follow four works which might loosely be compared, in the lower plants, with the wildflower guides, in terms of their usefulness to the beginner but inherent incompleteness of coverage.

Jennings, O. E. 1951. A Manual of the Mosses of Western Pennsylvania and Adjacent Regions. Am. Midl. Nat. Monogr. 6. 2nd ed. Univ. Notre Dame Press, Notre Dame, Ind. 396 pp. [Keys, descriptions, and drawings.]

Prescott, G. W. 1951. Algae of the Western Great Lakes Area. Cranbrook Inst. Sci. Bull. 31. 946 pp. [Keys, brief descriptions, and drawings for the algae, exclusive of desmids and diatoms, of Wisconsin and Michigan.]

Schuster, Rudolf M. 1953. Boreal Hepaticae. A Manual of the Liverworts of Minnesota and Adjacent Regions. Am. Midl. Nat. 49: 257-684. [Keys, descriptions, excellent drawings, and maps (for Minnesota.) $4.00]

Welch, Winona H. 1957. Mosses of Indiana. Indiana Dept. Conservation, [Indianapolis 9]. 478 pp. [Keys, descriptions, and drawings. $5.00]

Conard, Henry S. 1956. How to Know the Mosses and Liverworts. Rev. ed. Wm. C. Brown Co., Dubuque, Iowa. 226 pp. [A volume in the familiar Pictured-Key Nature series, with illustrated keys to many of the North American mosses and liverworts. $3.00 cloth, $2.50 paper]

Hale, Mason E., Jr. 1961. Lichen Handbook. Smithsonian Inst., Washington. 178 pp. [Over half this little book is an introduction to the study of lichens. The remainder consists of keys, with some drawings and photographs, for the forested (not Arctic nor alpine) region of eastern North America. $4.00]

Prescott, G. W. 1954. How to Know the Fresh-Water Algae. Wm. C. Brown Co., Dubuque, Iowa. 211 pp. [Another Pictured-Key volume, covering many of the common species. $2.75 cloth; $2.25 paper]

Smith, Alexander H. 1958. The Mushroom Hunter's Field Guide. Univ. Mich. Press, Ann Arbor. 197 pp. [Keys, field characteristics and habits, and outstanding photographs for many conspicuous fleshy fungi, particularly of the northern U. S. $4.95]

New Literature Relating to Michigan Botany

Space prohibits inclusion of a long list of journal articles in this issue, but we will continue in the next, with the ultimate aim of covering all significant literature relating to Michigan botany published since the beginning of 1960. (Items in applied fields, such as agriculture, will generally not be included, nor will articles in THE MICHIGAN BOTANIST or "Michigan Conservation.") Maps and other background documents useful to the field naturalist will be listed first, followed by books, bulletins, and articles which definitely refer to Michigan plants. When the subject matter or relation to Michigan is not clear from the title, annotations are added in brackets.

A. MAPS, SOILS, GEOGRAPHY, GEOLOGY

Topographic maps, published by the U.S. Geological Survey, Washington 25, D.C., are available from the Survey at $.30 each (20% discount on orders for $10.00 or more). Unless request is made to the contrary, maps are supplied when available with green overprint showing woodland areas (an especially useful feature to botanists). Standard quadrangles represent a unit of 15 minutes each of latitude and longitude (a scale of approximately 1 inch = 1 mile), and are named for a prominent feature in the area. Maps on a larger scale (7-1/2-minute quadrangles) are marked with an asterisk (*) in the list below. An index map of Michigan, showing the location of all quadrangles for which maps have been published, is available without charge. The name of the county in which each quadrangle listed below primarily lies has been added in brackets. The following maps were published in 1960:

Baldwin [Lake]
Big Rapids [Mecosta]
Clare [Clare]
East Tawas [Iosco]
Evart [Osceola]
*Frontier [Hillsdale]
*Hillsdale [Hillsdale]
Howard City [Montcalm]
Lake [Osceola-Clare]
Ludington [Mason]
Montague [Muskegon]
*North Adams [Hillsdale]
*Reading [Hillsdale]
Reed City [Lake]
Sand Lake [Newaygo]
Tawas City [Iosco]
Twin Lake [Muskegon]
White Cloud [Newaygo]
Woodville [Newaygo]

Soil Surveys, published now by the Soil Conservation Conservation Service of the U.S. Department of Agriculture, include maps which are often very useful in the field. Of Michigan's 83 counties, 31 have never had complete published soil surveys, even of the more primitive type of a half-century ago. The three counties listed below represent the first surveys to be published for the state since the Newaygo County survey issued in 1951 (since which the page size of the reports has nearly doubled):

Montcalm County (issued 1960). [Includes 60 maps on once-folded sheets, showing soil types, in colors, on a scale of about 3'' to a mile. $2.50]

Sanilac County (issued 1961). [Includes 253 full-page plates, on a scale of 4'' to a mile, with soil types outlined in red on aerial photograph base. $4.25]

Lenawee County (issued 1961). [Includes 72 once-folded plates, on a scale of about 3'' to a mile, with soil types outlined in red on an aerial photograph base. $3.00]

The two 1961 surveys, including as they do complete aerial photographic coverage of the counties, should be extremely useful to anyone planning to botanize in those areas. The reports are sold by the U.S. Government Printing Office at the prices indicated. In addition, each congressman receives an allotment for distribution in his district. (Representative George Meader advises that he has given his allotment of Lenawee Co. surveys to Michigan State University.)

Inland Route, Michigan. Chart No. 660, ed. of 1960. U.S. Lake Survey, Corps of Engineers, 630 Federal Building, Detroit 26. [A series of 11 maps, with plastic binding, showing in general and in detail the ''Inland Route'' from Cheboygan to Crooked Lake, in Emmet and Cheboygan counties. Would be invaluable to anyone exploring for aquatic or shoreline plants. $1.00]

County Maps. 1961. Michigan Department of Conservation, Lansing. [It is difficult to be restrained in praise for the handsome brand-new county maps just off the press, Books for Region I (Upper Peninsula) and Region III (Southern Lower Peninsula) are now available at $1.00 each; Region II (Northern Lower Peninsula) will follow. The old county maps from the Conservation Department were very useful, even though the base in most cases was 20-30 years old. The new maps, presumably based on recent aerial photography, topographic maps, and field experience, are exceedingly welcome. The page size is now a large 14 x 18 inches, and all maps are on a uniform scale of 3/8 inch to a mile. As before, back roads, trails, camps, and such features are shown. State and federal ownership appears in gray shades. Public fishing sites, roadside parks, campgrounds, and other recreational facilities are clearly marked.]

B. BOOKS, BULLETINS, SPECIAL REPORTS, AND MISCELLANEOUS

Anon. 1961. A proposed Sleeping Bear National Seashore. Natural History Report. National Park Service, Washington. 45 pp. [An excellent summary of the geological and biological features of the Sleeping Bear region, and it is unfortunate that the author has not been given credit for producing it. The ''Bibliography'' omits several basic papers on the region, and the list of common and scientific names of plants was apparently not proofread by a botanist. The scientific name of the American Elm is not *Viburnum trilobum*. The Wild Leek listed on page 38 was surely *Allium tricoccum* and not the European *A. ampeloprasum*. Except for such readily evident slips, a fine piece of work!]

C. JOURNAL ARTICLES.

[To be listed in the next issue, as well as additions to the above lists.]

PROGRAM NOTES

[Further information on the events listed below will presumably be made available to members of the respective organizations and institutions.]

MICHIGAN BOTANICAL CLUB

March 11: State Meeting, Ann Arbor High School. Clarence Messner, active Michigan naturalist and member of the Conservation Commission, will speak on State Parks and Conservation.

SOUTHEASTERN CHAPTER, Michigan Botanical Club

February 23—March 4: Flower Show at Cobo Hall. Visit our exhibit.
March 11: State Meeting, Ann Arbor (see above).
March 17: St. Patrick's Day. George Thomson will show slides on Ireland.
May 5: Work party at the Stony Creek Area, near Rochester.
May 19: Field trip to Barber Woods, near Vermontville, led by Paul Thompson.

HURON VALLEY CHAPTER, Michigan Botanical Club

March 11: This chapter is host to state meeting (see above).
April 16: Annual meeting of the chapter. Edward Voss will speak on "Geological and Floristic Observations about the Upper Great Lakes."

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MICHIGAN AUDUBON SOCIETY

June 1-3: Spring campout, Sleeper State Park, Huron Co.

CRANBROOK INSTITUTE OF SCIENCE

April 6: Member's Lecture. Richard A. Howard, Director of the Arnold Arboretum, Harvard University, on "Botany in a Supermarket." (Admittance by ticket only.)
April 21-May 19: Field Natural History. Five Saturday field trips for Junior Members of the Cranbrook Institute, in Michigan, Ohio, and Ontario, under leadership of Walter P. Nickell.

MICHIGAN ACADEMY OF SCIENCE, ARTS, AND LETTERS

March 22-24: 66th Annual Meeting, Ann Arbor. The Botany Section will meet in the Rackham Building amphitheatre Friday, March 23, at 9:00 and 1:30; and Saturday, March 24, at 9:00. A total of 39 papers are on the full program. Visitors are welcome.

UNIVERSITY OF MICHIGAN

Dr. Eric Hultén, Director of the Botanical Department, Naturhistoriska Riksmuseum, Stockholm, Sweden, will be a Research Associate in the University Herbarium for several months this spring and summer, studying Arctic collections in connection with a revision of his well known *Flora of Alaska and Yukon.*

Dr. D. J. Donald Nicholas, Head of the Plant Biochemistry and Chemical Microbiology Department of the University of Bristol, England, and currently Visiting Professor in Biochemistry at the University of Wisconsin, will give a Botany Department seminar on March 14 and a University Lecture on March 15.

Dr. F. A. Stafleu, of the Botanical Museum and Herbarium of the University of Utrecht, Netherlands, and assistant editor of *Taxon* and other publications of the International Bureau for Plant Taxonomy and Nomenclature, will be in Ann Arbor the first week of May for a Botany Seminar on May 2 and a University Lecture May 3.

Dr. Faustino Miranda, Director of the National Herbarium of Mexico, and the principal authority on the vegetation of southern Mexico, is studying Mexican plants in American herbaria with the aid of a Guggenheim Fellowship, and plans to spend a few weeks in Ann Arbor in April or May.

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THE

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Kichi L.
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Mississippi R.
L. Vandermaelen
Lake Sagidowaa R.
L. Marquette
L. Lasalle
L. Plantagenet
R. Laplace
1456
1406
1540
Allen's Bay
Moss L.
Pickering Bay
L. Duponceau
Little Winibigoshish L.
Cleared Pine Camp
Leech Lake R.
Pogadowan R.
Deer R. & Lakes
Oak Pt.
Eagle Nest
Savanna
L. Bessel
Mashkudens R. & L's.
Swan L.
The Two Rivers
E. Swan R.
Wanomon R.
1356
Pakegoma
Kabikons or Little Falls
Trout C. & Ls.
Rapids
Blueberry C.
Embarrass
W. Swan R.
1290
Kabekona L.
Neway L.
1680
THE MISSISSIPPI
L. Herschel
L. Baily
Lit. Long L.
Warpool
L. Babbage
L. Poisson
L. Bouvard
L. Prony
L. Sabine
L. of the Mountain
L. of the Island
L. Kaginogumag
Lit. Vermillion L.
Birch L.
Lac Pelé
L. of the Isles
L. Boutwell
Lac Vieux Desert
Summit L.
Long Rice L.
Allens L.
Johnstons L.
Shell R.
L. Conrad
L. Leetine
Trout L.
L. Pillot
L. Chotard
L. Hull
Pine R.
Ikwe L.
Gauss
L. Hassler
Little Boy R.
L. Deluol
Kwiwisens R.
L. Portier
L. Eccleston
L. Brule
L. Rosati
Cut Hand C.
Small Rapids
L. Aitkin
E. Savanna
L. Enke
L. Chanche
Little Willow R.
Willow R.
Rapids
1253
1334
1400
W. Savanna R.
Little Prairie R.
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L. Stewart
L. Guenebault
Mashkosiwah L.
Gayashk R.
L. Gratiot
Manido R.
Kadikomeg L.
Plymton L.
L. Sibley
L. Taliaferro
L. Davenport
1176
Nanomin R.
Muddy Lakes & R.
L. Dodge
Red Cedar L.
Rabbit C.
RIVER
7th or French Rapids
Nagajika C.
MISSISSIPPI
MINSI SAGAIGONING
Leaf R.
Crow Wing R. or R. Kagiwigwan
Riv. aux Perdrix
1130

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TRICHOLOMA IRINUM IN MICHIGAN

Alexander H. Smith
Herbarium, The University of Michigan

For years the problems arising from advising the general public on the subject of eating our native species of mushrooms have been of interest to me and have occupied my time to the extent of giving individuals advice and guidance as well as teaching extension courses on the subject in southeastern Michigan. Consequently any developments which concern this phase of mycology are important to me both as an investigator and a teacher. It is common knowledge that there are many hazards involved in eating wild mushrooms both from the standpoint of variability within the population of human beings as well as within our population of native mushrooms. Strong public interest remains in spite of the hazards, and in the last few years interest in both edible and poisonous species has been greatly stimulated through the work that has been done on the properties of many of the poisonous species, such as the effect of the poisons on the human mind. But the increase in public interest brings an increase in the number and scope of the problems confronting a mushroom specialist.

Because of the difficulties involved in advising the public as to edible and poisonous species, every specialist who tries to be of service soon finds himself subject to considerable criticism. This a specialist must take for granted, and if it is an unbearable annoyance he should not offer advice or try to be of help. I have found myself criticised as being too cautious on the one hand, and on the

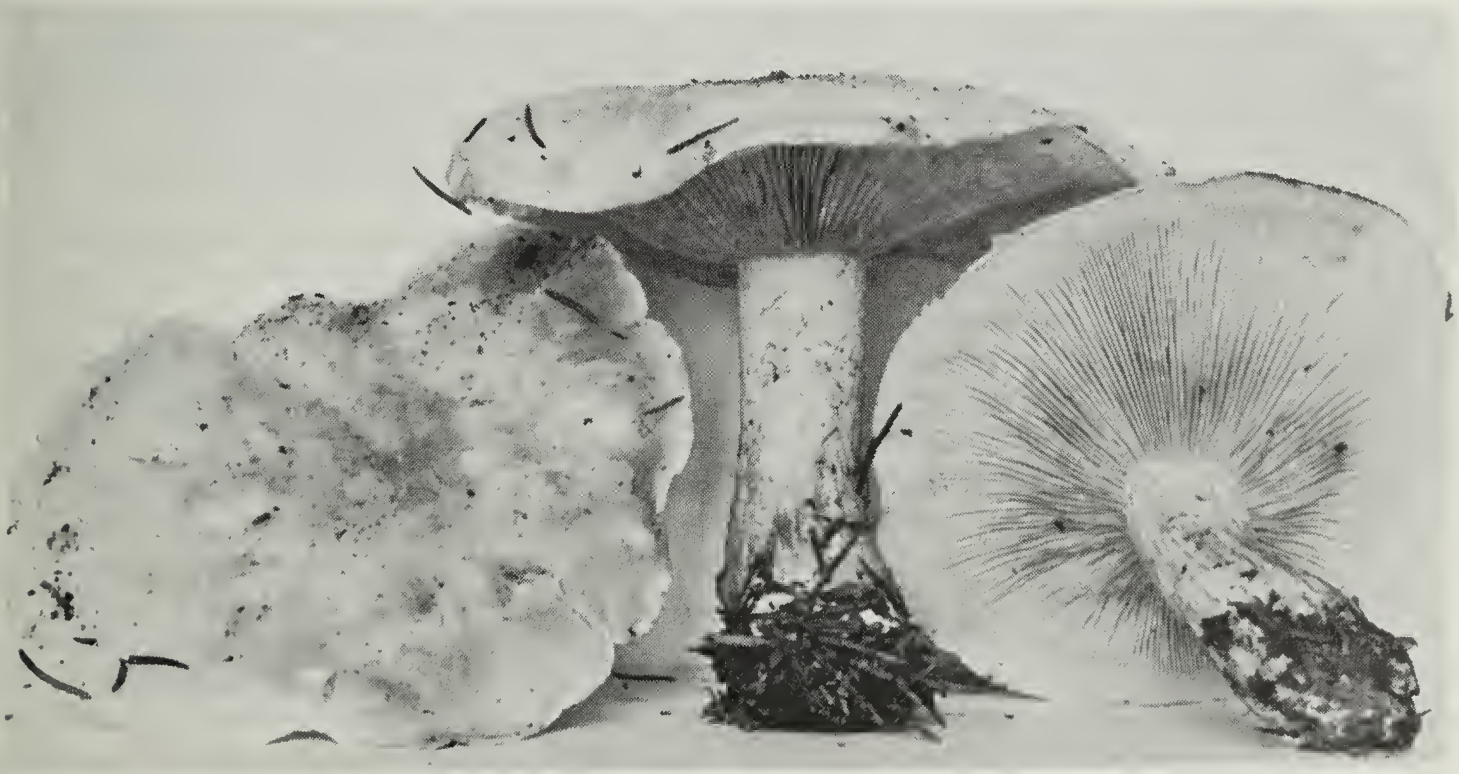

Fig. 1. *Tricholoma irinum* (Fr.) Quél. (reduced)

other for not accepting every statement in the literature on poisonous fungi at its face value. I have even been criticised when it was obvious that the critic and I both held the same view. This last mentioned situation developed from a review I wrote (Mycologia 50: 449-452. 1958) of the Wassons' excellent two-volume work.

To illustrate the type of situation which gives cause for honest disagreement between people, and which can react unfavorably to the reputation of any specialist trying to help the public, I should like to describe a case which occurred at Ann Arbor during October, 1958.

The species involved was *Tricholoma irinum* or *Lepista irina* depending on which classification one prefers to follow. This mushroom is generally rated as a good edible species, and furthermore, the group of closely related species to which it belongs is generally regarded as safe and actually contains such fine edible species as *Lepista nuda* and *L. personata (Tricholoma)* of the popular mushroom books. For the past five or six years I have identified *T. irinum* for a number of my colleagues here on the University faculty, and they have enjoyed eating it so much that they formed the habit of making regular trips to a local conifer forest to collect it. No one suffered any ill effects and they all soon learned to know the species well enough to make their own identifications. In the fall of 1958 the crop was exceptionally good. One of our graduate students took a large quantity home for canning and he and his family enjoyed the species all winter. I personally harvested a bushel basket full of the fruiting bodies from a single fairy ring, the one from which other collectors had been getting their material. These specimens were distributed to eleven friends and acquaintances, and Mrs. Smith saved some for us. Counting my own family, fourteen people ate from this gathering. Twelve people (including myself, wonder of wonders!) ate them and suffered no ill effects. Two people, however, a man and wife, had severe gastrointestinal upsets characteristic of a ''mild'' case of mushroom poisoning, although they object to the word ''mild.'' The following is a history of the case as recorded by the husband.

> Dr. Smith had collected the mushrooms in the morning. I picked them up at his house at about 11:30 a.m., took them home, cleaned them, and stored them in the refrigerator. That evening, my wife prepared a quantity of the mushrooms for dinner, frying them in butter. They were cooked thoroughly.
>
> Dinner was served at about 6 p.m. In addition to the mushrooms the menu included fish, canned spaghetti, canned peas, fresh head lettuce and fresh blueberry pie. Neither of our children ate any of the mushrooms, because they do not like mushrooms. They did eat some of everything else.
>
> I personally consumed approximately six caps, my wife about half that quantity. The caps selected were from two to four inches in diameter. As we ate them, we both remarked that they were the best-tasting mushrooms we had ever eaten. We discussed preparing another panful, but decided against it because the species was new to us.
>
> Dinner was finished about 6:45. At about 7:30 parents dropped in for a visit, and we remarked to them about the excellent mushrooms we had for dinner. They left about 9:15. Shortly afterward, my wife remarked that she felt suddenly and

inexplicably tired, and thought she would go to bed early. I had been working at my desk, and at about the same time I noted an inability to concentrate on the rather simple job I was doing. After persisting briefly but unsuccessfully for a few minutes I gave up. We both retired about 10 p.m. and fell asleep promptly.

At approximately 12:30 a.m. my wife awakened me and complained of severe stomach cramps and nausea. She vomited twice and experienced diarrhea. She returned to bed about 12:45, at which time I began to experience very severe stomach cramps. I did not vomit but did have diarrhea which persisted for almost an hour. During that period, my wife had another attack of vomiting and nausea. We both returned to bed about 1:15 and slept without further incident until 7:30 a.m.

On awakening, I suffered a slight headache and felt a general weakness. My wife complained of a backache and said she didn't feel "up to par". Neither of us had any appetite for breakfast, and we restricted ourselves to black coffee.

We did not fully recover until about noon.

Neither of our children, who did not eat the mushrooms, showed any symptoms of illness.

Both my wife and I had had one cocktail before dinner, as is our custom. I had, in addition, taken an antihistamine pill and an achromycin tablet during the evening. Both had been prescribed by a physician for treatment of an ear infection.

Although I had eaten about twice as many of the mushrooms as my wife, my illness was only about half as severe as hers.

Both of us have eaten commercially sold mushrooms regularly. We have also eaten a number of wild species, including three types of morels (*Verpa bohemica, Morchella esculenta,* and *Morchella angusticeps*), *Armillaria mellea, Hygrophorus russula, Lycoperdon perlatum,* and *Calvatia gigantea.* None of these produced any illness of any kind.

From the evidence, I am convinced that the mushrooms—and not something else—caused the illness in this instance.

My first thought on reading this report was that alcohol might be the deciding factor but on checking back with the others who ate from the same gathering I found this not to be true. Some who suffered no ill effects whatever had had an alcoholic beverage with the meal at which the mushrooms were consumed.

Admittedly this was not a serious case from a medical standpoint, but to the individuals involved it was sufficient to cause them to place *T. irinum* on their "black list." They want no more of it. Fortunately the couple involved had been warned about the possibility of this type of an occurrence happening sometime, and they did not panic at the signs of distress.

No advisor on mushrooms can hope permanently to escape encountering such a situation as this. Fortunately, I had examined every cap in the collection carefully enough in the field to be sure of its identity, had taken a number of spore prints, and had checked samples from this fairy ring microscopically. A case of this kind is rarely so well documented.

Tricholoma irinum is not well known in the American literature, but the characters, even to the truly fragrant odor, check so well with data given by reliable European authors that there seems to be no reason to doubt the identification. It should be mentioned, however, that in the last ten years I have had this species not only from the fairy ring in the conifer plantation mentioned, but also from under hardwoods, and that it may occur truly gregariously as well as in arcs or rings. I have never been able to establish any taxonomic characters by which the material from under conifers could be separated from that under hardwoods. The variation in the same fairy ring from one year to the next, depending on how wet or dry the weather is, is greater than that between material from the location under conifers and that from under hardwoods during the same season. The following description is taken from material collected from the fairy ring under conifers.

Tricholoma irinum (Fr.) Quél. Fig. 1.

Pileus 4-12 cm broad, obtusely umbonate with an inrolled margin, expanding to plane or nearly so, often retaining a low broad umbo, the margin sometimes lobed or wavy, surface smooth, subviscid to the touch as in *Melanoleuca* but pellicle only slightly separable at the most, soon dry, sometimes pitted or with watery spots, margin white-cottony and occasionally sulcate-striate from pressure against the gills, color whitish when young or in dry weather, normally soon changing to pale dingy buff to pale pinkish cinnamon, when old and water-soaked often dingy alutaceous. Context thick, soft, whitish to pinkish or watery avellaneous; odor sharply fragrant though often faint; taste mild.

Lamellae narrow but finally moderately broad, crowded, 3 or more tiers of lamellulae, broadly adnate to subdecurrent, whitish ("tilleul buff") young becoming pale avellaneous or tinged more vinaceous (regularly darker than the color of the spore deposit), edges even to uneven.

Stipe 4-8 cm long, 1-2.5(3) cm thick at apex, equal to clavate, solid, watery avellaneous within, soon whitish, surface pallid at first and fibrillose to slightly scabrous, in age finally sordid avellaneous and longitudinally striate, if scaly the scales formed of parts of the torn cuticle, base with a copious mycelium binding the debris; no veil present.

Spore deposit "pale pinkish buff"; spores 6.5-8 x 4-4.5 μ, very slightly roughened (use oil-immersion lens), ellipsoid, yellowish in Melzer's reagent; basidia 4-spored, 28-34 x 7-8 μ; pleurocystidia none; cheilocystidia absent to rare, usually scattered, 10-28 x 2.5-2.5 μ, filamentous and flexuous; gill trama homogeneous beneath a thin subgelatinous (in KOH) pellicle of narrow (2-3 μ) hyphae appressed over surface; hyphae of context 5-12 μ in diam.; clamp connections present.

In a fairy ring, subcespitose-gregarious under spruce in a plantation. Usually fruiting late in the season.

Some might argue that minor upsets such as the one described here are not important—that they have little bearing on the question of which species are actually poisonous. But those who suffer the discomforts are quite strongly of the opposite opinion. Any specialist who does not take into account the variability between human beings in their ability to tolerate different species of mushrooms is doing the public a disservice, and will eventually suffer personal embarrassment.

It has been amply demonstrated in the literature on obligate parasites, such as the plant rusts, that the physiological characteristics of both the host and the parasite must be taken into account. Hence the term "physiological races" (or "strains") has become prominent in the literature on rust fungi. Although the approach is a little different as far as mushrooms are concerned, examples like the one I have just presented indicate that there are differences between people as to their tolerance for a particular species of fungus.

It is for this reason that as the years go by I find myself becoming less and less patient with those who treat lightly the dangers of mushroom poisoning. A corollary to this is that in general and technical works on fungi, species should be accurately described and illustrated. The beginner needs this even more than does the specialist.

GREEN DRAGON *(ARISAEMA DRACONTIUM)*

Emma J. Cole [1]

In 1892 a small patch of *Arisaema dracontium* was discovered in the vicinity of Grand Rapids, Michigan. It grows sparingly along Grand River in shaded alluvial soil. This same year one of the stronger plants was transplanted to the flower garden for closer observation. Its corm was then about 4 cm in diameter, and its flower spike bore at its base pistillate flowers surmounted by staminate ones, as in the monoecious plants of the common Indian Turnip. The flowerering part of the spike was about equally divided between the two kinds of flowers.

Its location in the garden was scarcely moist enough. It produced only one offset from its corm during the first three years. It bloomed each year, but the spike withered soon after flowering. The plant seemed sterile with its own pollen.

It was transplanted to another place in the garden where the soil seemed more in accordance with its native conditions. The plant now attained the maximum height and breadth of 8 dm. Its corm had increased to 8 cm. During this ranker growth it began to send off numerous offsets from its corm. On account of the crowded condition of the young plants the majority of them have always died at the close of their first year. Those that survive produce staminate flowers about the second or third year after they bear leaves.

The first season that a staminate plant appeared, the parent plant retained its flower spike. Some half dozen of the pistils increased in size, but they all reddened. As the number of staminate plants increased, each year the pistils of the parent plant developed better fruit, but at no time were there more than one-half of the berries well filled with pulp and seeds. In its native habitat I have never found the proportion greater. The pistillate part of the spike increased to about two-thirds of its flowering portion, while the staminate part diminished proportionately. This parent plant survived

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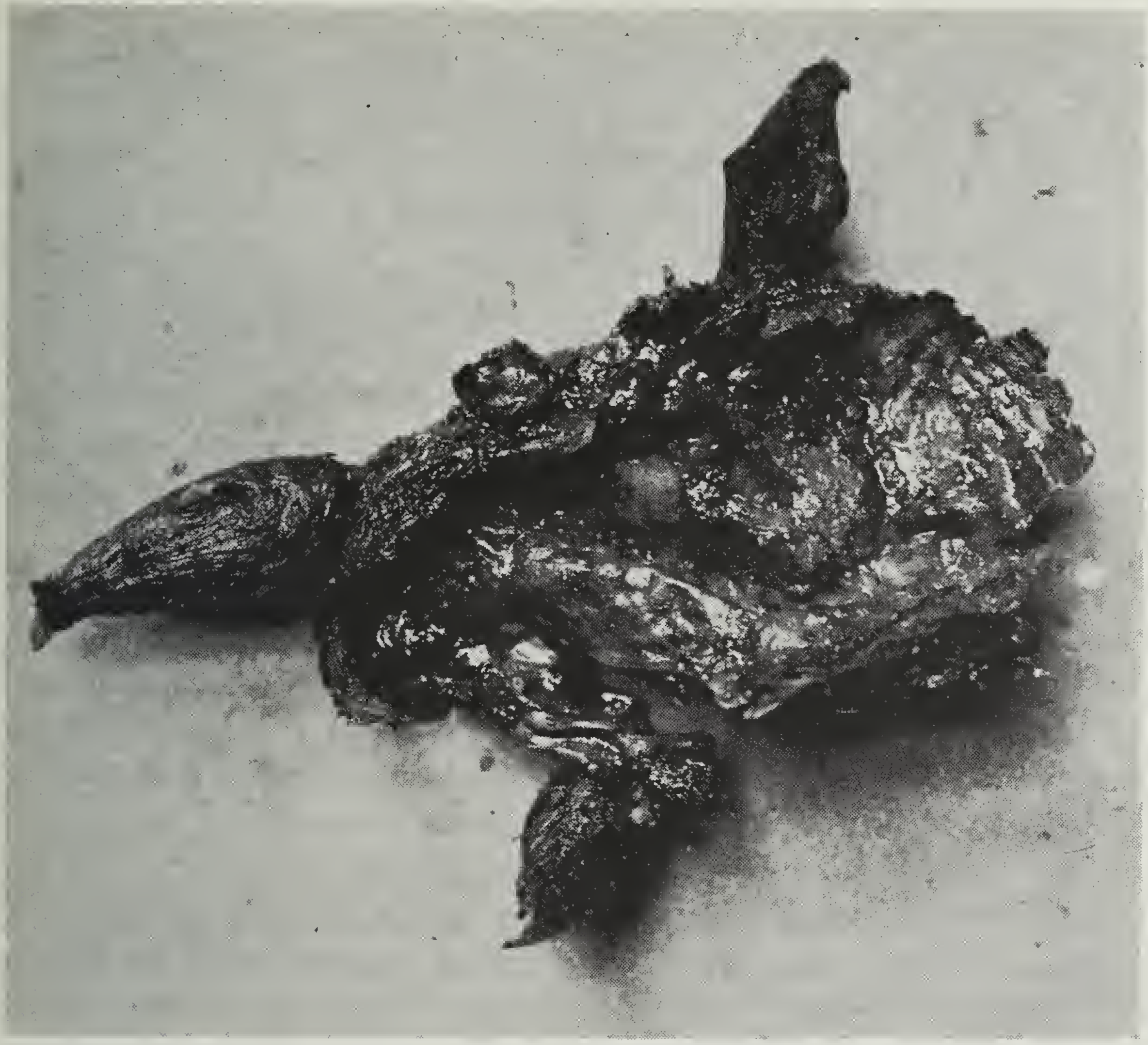
[1] Miss Emma J. Cole, author of the remarkably fine *Grand Rapids Flora* published in 1901, was born in 1845 and died in 1910. From 1881 until 1907 she taught at Central High School in Grand Rapids. She evidently influenced a large number of people in the study of botany, and she will surely be worthy of a biographical treatment one day in THE MICHIGAN BOTANIST. This paper on *Arisaema dracontium* was apparently prepared at about the time of her retirement in 1907; the manuscript, written in her own hand and signed by her, was discovered in 1960 among the effects of the late Professor H.H. Bartlett, of the University of Michigan, with no further evidence of its origin or intent. It is printed here with almost no editorial changes from Miss Cole's text, except that some aged photographs have necessarily been omitted. She concluded her manuscript with the statement: "The photographs illustrating this paper were made by Joseph Horner."

—E.G.V.



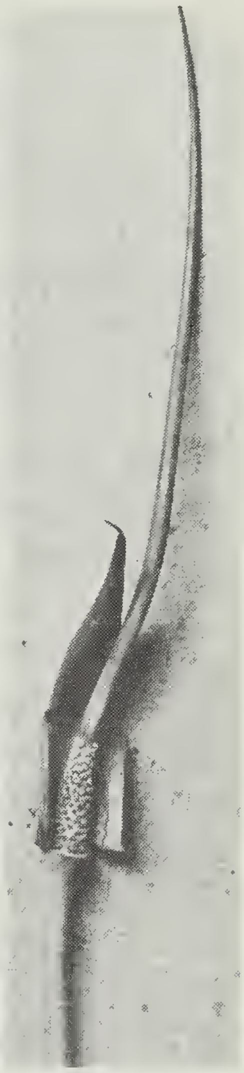


Fig. 1. (left). Corm base and offsets. Fig. 2. (right). Staminate inflorescence.

ten years in the garden, and there were 87 plants in the patch (including the young ones which die at the close of the season); of the 15 that bloomed, 7 were strong enough to develop pistillate flowers, but only 4 developed fruit. In the spring of 1906 there were 90 plants; of these 17 bore staminate flowers, 6 pistillate and staminate, of which 4 developed fruit.

This year paper sacks were placed over 3 spikes with pistils to exclude insects. Two of these withered. The third one remained for a time, but only a dozen pistils enlarged and they did not contain seeds.

The plants are propagated [vegetatively] by offsets; the number varies with the size of the corm. The most observed on any one corm were ten. Buds appear at the node of the previous year's growth in spring and summer. The second year these buds develop the offsets. These vary in thickness and length. Besides the terminal bud there may be two or three others along the sides. At the end of the second year the base of the corm becomes gelatinous and sloughs off and the offsets are released. Figure 1 shows a base with three offsets. The third year the buds on the offsets commence their growth as individual plants. Each bud thickens at its base and the connecting links between the buds die off. The leafstalk usually has three leaflets, but in the stronger plants the lateral ones may be divided. The majority of these survive only one season.

Of the stronger and more favorably situated young plants, it required two or three years before they produced staminate spikes (Fig. 2), and some more before they became pistil-bearing (Fig. 3).

The greatest number of flowering plants during any one year for a period of 14 years was 17 staminate plants and 6 with both pistils and stamens. The pistillate flowers on the spike increase [in number] and the staminate flowers diminish with the age of the plant. The spike develops better filled berries the older and stronger the plant is. The berries contain from one to three well developed seeds. These germinate the following year; a tiny corm is formed with one or two rootlets at its base, but it [a shoot] does not appear above the ground till the second year.

The corm has its greatest diameter a little above its base. This enlarges with the age of the plant. Each year's growth is visible on its exterior in horizontal circles where the scape and the sheathing bud scales of the terminal bud were attached. Each corm represents two years of growth. The old growth below these becomes gelatinous and sloughs off with the offsets. In a longitudinal section of the corm the node tissue is plainly visible as a colored line.

The rootlets appear each season at the node or where the new growth commences. These soon have a wrinkled appearance, as those of the Skunk-cabbage and many other succulent rootlets of rhizomes and bulbs. This is due to the fact that their woody fibers contract and this gives the epidermis its wrinkled appearance. The value of this is to pull the plant downward into the place occupied by the decaying corm base and keep it at its proper depth beneath the soil.

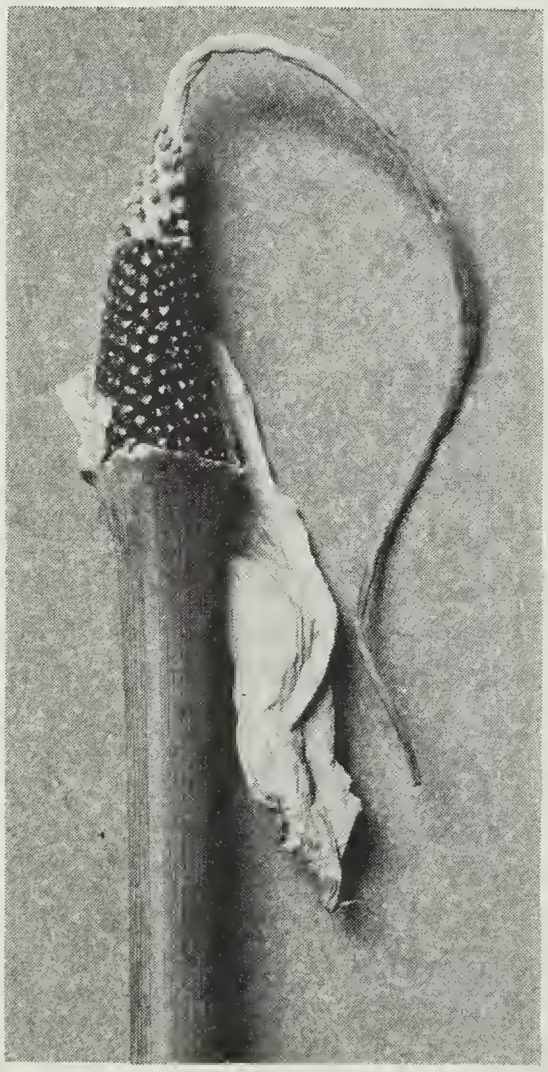


Fig. 3. Pistillate inflorescence

SUMMARY

It will appear from these observations that *Arisaema dracontium* is sterile with its own pollen but is capable of porducing seeds with the pollen of its offsets.

All plants seem to be staminate in their first stages of growth, and as they increase in age and strength they bear pistils. The pistillate part of the spike increases with the size and age of the plant, and its staminate part diminishes proportionately.

There is rarely any fruit produced the first season that the pistils appear.

None of the plants studied, although some of them have attained twelve years of age, have ever been found to be wholly pistillate.

It is quite probable that the common Indian Turnip [*Arisaema triphyllum*] reproduces itself in this same manner. So far as I have been able to observe its habits, they are very much the same. The weaker plants with one leafstalk bear the staminate flowers, while the stronger plants have two leafstalks and may either be partly or wholly pistillate. The structure of the corm is quite similar with its buds, offsets, and mucilaginous corm base. The staminate plants often appear in bunches as those of *Arisaema dracontium*.

A Reminder

Members of the Michigan Botanical Club are reminded that dues were payable to your Chapter treasurer August 1. State members (i.e., individual members not belonging to the Southeastern, Northwestern, or Huron Valley chapter) should send their dues of $2.00 to the state treasurer, Charles H. Buswell, 19204 Plainview, Detroit 19, Michigan. THE MICHIGAN BOTANIST for the succeeding calendar year is not sent to any members whose dues are in arrears. Subscribers who are not members will receive bills from the business and circulation manager.

Review

MICHIGAN WILDFLOWERS. By Helen V. Smith; illustrated by Ruth Powell Brede. Cranbrook Institute of Science (Bulletin 42), Bloomfield Hills, Mich., "1961" [1962]. xii + 465 pp. (incl. 231 plates) + 17 color plates. $5.00.

This long-awaited Cranbrook publication on common flowering plants of Michigan is a rich source for valuable information and fills a definite need. Included are over 70 families with nearly 500 species (chiefly herbaceous) of the showy, common, or unusual wildflowers of the state.

Line drawings, mostly one or two on a page, illustrate a large majority of the species and are conveniently arranged to accompany the plant descriptions. There is space for enlarged drawings of floral parts and other important structures, and such sketches would have been helpful. However, in most cases the drawings are simple and accurate and portray very well various characteristics of plants—such as the delicacy of meadow-rue, the softness of catnip, and the prickliness of teasel. Seventeen delightful color plates, representing flowers of various seasons and habitats, add considerably to the attractiveness of the book.

The simplified botanical keys should prove easy to follow, especially with the aid of the sketches in the five-page illustrated glossary on plants and their parts, inflorescence types, leaf characteristics, and other items.

The main body of the book treats the species, grouped in their respective plant families. Information about each family highlights the family characteristics given, with the number of genera and species in the world and the status of Michigan's representatives usually included.

Very good descriptions accompany each species, as well as remarks on habitat preference and months of flowering. Distribution maps, such a valuable inclusion in other Cranbrook publications, will be missed. However, distribution is mentioned to a certain extent and perhaps it is not feasible to include such maps. Notes follow the descriptions of many species and are packed with unusual and interesting facts touching on a variety of subjects. Special attention is given the following: relationships to birds and mammals as regards food, poison, and so on; desirability as ornamentals; former uses, particularly by the Indians, as foods, medicines, and fibers; source of origin if a weed; and present-day aspects.

Of interest and value is the section on conservation of wildflowers, which includes a list of species that are protected by law in Michigan. Throughout the book, as each species is dealt with, the protected plants are clearly indicated. Also good is the paragraph on conservation organizations and governmental agencies that are interested in wildflower protection and preservation of natural areas.

Of pleasure for many will be the remarks on growing plants for the home wildflower garden. Following this is a list of plants easy to grow and obtain, with suggestions concerning their requirements. The page of selected references includes five books on the growing of wildflowers, and scattered throughout the book are interesting notes concerning plants for the wildflower garden.

A sizeable glossary plus an index to Latin names as well as a second index to common names are also included.

In my opinion this is an attractive, helpful, definitive book with a wealth of information on wildflowers of Michigan. I am sure that many people will gain new insights, knowledge, and pleasure from wildflowers through the use of this fine book.

—Mabel Jaques Cuthbert
Mount Pleasant, Michigan

DOUGLASS HOUGHTON'S BOTANICAL COLLECTIONS IN MICHIGAN, WISCONSIN, AND MINNESOTA ON THE SCHOOLCRAFT EXPEDITION OF 1832

Janice L. Rittenhouse and Edward G. Voss
Herbarium, The University of Michigan

In his day, Henry Rowe Schoolcraft was a man of great renown as scientist, Indian authority, poet, and author of books on the exploration of the Northwest. Today, one of the best remembered of his many accomplishments is his discovery of Lake Itasca, Minnesota, as the source of the Mississippi River.

As mineralogist with the expedition of Lewis Cass, then territorial governor of Michigan, Schoolcraft had reached Upper Red Cedar Lake (renamed Cass Lake) in 1820; although there are some conflicting records, apparently the party realized that they had not reached the source of the Mississippi (Mason, 1958, p. x). In 1822, Schoolcraft was appointed Indian agent at Sault Ste. Marie. He remained keenly interested in exploring the Northwest Territory, not only for the advancement of knowledge, but also because it would increase his prestige as an explorer and be an excellent basis for another travel narrative (see Mason, 1958, p. xii).

In 1830, the War Department asked Governor Cass to request Schoolcraft "to proceed into the Chippewa country, to endeavor to put an end to the hostilities between the Chippewas and Sioux." (Schoolcraft, 1834, p. iii) The following summer, Schoolcraft traveled some 2,300 miles in a 72-day expedition, visiting tribes in Michigan, Wisconsin, and northern Illinois. Included in his small party as physician was Dr. Douglass Houghton, who had come to Detroit from New York state in 1830 to give some scientific lectures and who so endeared himself to the people of Michigan that he returned—to become one of the state's most famous citizens. (See Rintala, 1954, for a sympathetic biography.) It was on the 1831 expedition that Houghton first reported copper in the Upper Peninsula of Michigan

Schoolcraft returned from this expedition knowing that he wanted to revisit the territory to find the "veritas caput"[1] of the Mississippi. He suggested that the Office of Indian Affairs should send another expedition into the territory the following summer, and confidently began

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[1] Boutwell's Latin, whence Schoolcraft derived the name "Itasca" (see Mason, 1958, p. xx).

ON THE COVER: The cover map, which helps to illustrate this article, is a portion of an 1843 War Department map, "Hydrographical Basin of the Upper Mississippi . . .," based on data from the explorations of Jean N. Nicollet in 1836 and other years. (Reproduced through the courtesy of the Map Room, University of Michigan General Library.)

gathering his company. The 35-man party finally included an interpreter, Mr. George Johnston (Schoolcraft's half-Indian brother-in-law); Rev. William Boutwell, invited by Schoolcraft to represent the American Board of Foreign Missions; 20 voyageurs; and a military escort of ten soldiers under the command of Lieutenant James Allen, from Fort Brady (at Sault Ste. Marie). All were to travel in a canoe and two Mackinaw boats, equipped with sails and oars, to Fond du Lac (the head of Lake Superior), then to abandon the boats for bark canoes.

When, in May of 1832, Schoolcraft received official authorization for the expedition, he found that its aims had been enlarged over his original proposal. Now the purposes were to extend peace, to investigate the condition of the fur trade and to determine the adequacy of trade regulations, and to vaccinate and to compile statistics on the Indians. (Schoolcraft, 1834, pp. v-vi)

For the vaccinations, as well as for the health of the company, a physician would be necessary; Schoolcraft invited Houghton. Houghton had already applied for a position as surgeon and naturalist on another exploring expedition,[2] but when he received Schoolcraft's offer, he decided to go on that expedition instead, since he would thus be able to continue the botanical work he had begun the previous summer. Many plants which he collected on these two expeditions (1831 and 1832) were sent to Professor John Torrey of New York University, then the country's leading botanist, who credited Houghton with several outstanding discoveries.

Houghton left incomplete information on many of the labels with his specimens, since he planned to publish an extensive list of the plants, dates, and localities at some future time. Unfortunately, the complete list was never published, and only a representative list survives (Schoolcraft, 1834, pp. 160-165; 1855, pp. 519-526). The following itinerary has been summarized mainly from the published reports of Dr. Douglass Houghton (in Mason, 1958), Lieutenant James Allen[3] (Allen, 1834; reprinted in Mason, 1958); Henry Rowe Schoolcraft (1834 and 1855; Mason, 1958); and Reverend William Thurston Boutwell (in Mason, 1958; partly in Boutwell, 1872). The plants listed below as "collected" are present in the University of Michigan Herbarium, where the identifications have been corrected as necessary. These specimens were for the most part included in Houghton's personal herbarium; numbers are often given on the backs of the original labels, sometimes with a notation like "same as sent to Torrey." These numbers are given in parentheses after the names of the species.[4] Other species and vegetational notes mentioned in the itinerary below are among those recorded in the published reports and have been included here for additional interest.

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[2] Lucius Lyon, a government surveyor, was to explore the Mississippi River below the Falls of St. Anthony and the Missouri River as far as Council Bluffs. Houghton not only gave up this opportunity in order to accompany Schoolcraft but also an offer to return home to Fredonia, New York, to practice medicine. Thus he cast his lot with the future state of Michigan!

[3] Allen's journal, though he was not a botanist, is consistently excellent in recording plants. Allen had been instructed to keep a report of the natural history of the country, and he apparently took his obligation quite seriously. Because Allen did not always keep pace with Schoolcraft's canoe, the dates of their respective camps are not always identical. The present itinerary is based on Houghton's dates, as he presumably collected all the plants.

Since many of the original labels back either dates or localities, this itinerary has been compiled as an aid in supplementing labels accompanying specimens (duplicates of those cited, or not) collected on the 1832 expedition. It has not been possible at the present time to study Houghton specimens which may exist in the Herbarium of the New York Botanical Garden (ex herb. Torrey), nor to complete a survey of the 1831 itinerary, which is less thoroughly documented than the 1832 expedition, although there are relevant data in Schoolcraft (1832, 1834 and 1855) and Mason (1958).

DAILY ITINERARY

JUNE

7: "Our object being, for this day, merely to make a start," the expedition left Sault Ste. Marie in the afternoon and traveled only 6 miles, to a point of general encampment on Point Aux Pins, on the Canadian side of the St. Mary's River.

8: The expedition passed into Lake Superior between Gros Cap and Point Iroquois, and encamped at Whitefish Point (stunted growth of white and pitch pine, a few small birch, and white cedars).

9: To Grand Marais bay. (Large white pine along the coast.) Collected: *Lycopodium annotinum* (8) (Vermillion Bay [west of Whitefish Point], sandy woods).

10: Sunday, so, following Schoolcraft's strong religious beliefs, the expedition did not travel. (The hills "to the S. S. W. covered with thick forests of birch and pine.")

11: From Grand Marais past Grand Sable dunes to Pictured Rocks. Camped opposite Grand Island. Collected: *Mitella nuda* (Pictured Rocks, damp woods).

12: Many of the men became seasick in a storm, so traveled only 8 miles. The party stopped at "La Rivière au Galet," 2 miles before the Au Train River.

13: Passed the rivers of Au Train, Laughingfish, Chocolate, and Dead. Finally, passing Presque Isle [Marquette], they arrived at Granite Point (named by Schoolcraft in 1820) and encamped beyond. Collected: *Primula mistassinica* (rocky shore, Presque Isle); *Pinus banksiana* (sandy soil, Yellow Dog River).

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[4] In a letter to Torrey dated November 24, 1932, Houghton wrote (as quoted in Mason, 1958, p. 305): "Nearly all the plants are labelled in my collection, but as it was done in great haste and under unfavorable circumstances . . . I have concluded to send them with the bare localities."

14: Passed the Huron Islands and the mouth of the Huron River, stopping at Point Aux Beignes (Pt. Abbaye). Collected: *Cerastium nutans* (Pt. Abbaye).

15-16: Schoolcraft set out in his canoe (in which Houghton was also traveling) to visit trading posts and make the crossing of the Keweenaw Peninsula by Portage Lake and the portage to the north side of the Peninsula [present location of the Portage Ship Canal]. The Mackinaw Boats were obliged to take the dangerous longer route around Keweenaw Point. Collected: *Triglochin maritimum* (marsh of Keweena Pt. portage); *Chrysosplenium americanum* (marsh, portage, Keweena Pt.); *Menyanthes trifoliata* (marsh, Keweena Pt.).

17: Sunday. The party reunited near the end of the portage. The forest surrounding the encampment is heavy birch, sugar maple, large pine, and hemlock.

18: Traveled only 27 miles, to La Rivière à Misère [Misery River]. (Range of hills 1-2 miles from camp is covered with pine, birch, and sugar maple, but the country is so poor in game that traders have starved, whence the river's name—as related by Allen.)

19: Past the Ontonagon and Iron Rivers, to the mouth of Carp River. Collected: *Equisetum palustre* (marsh, Ontonagon River).

20: To Presque Isle River, past Black River, across Montreal Bay, to La Pointe Island [Madeline Island, Wisconsin].

21: After business with the Indians, they traveled late in the day to encamp on the mainland near La Pointe Chegoimegon [Chequamegon Pt.].

22: Past the Apostle Islands, then Birch Bark (Middle) Point to Bois Brule River.

23: Reached the Fond du Lac [St. Louis] River (from whose irregular shore run many promontories supporting a thick growth of small trees, aspen, birch, tamarack, "and other species of pine"). At the Fond du Lac Post, 20 miles upriver, they arranged to leave the boats for bark canoes to be picked up at the other end of the Grand Portage. (Luxuriant *Poa compressa*.)

24: Sunday.

25: Two miles farther, commenced the Grand Portage, avoiding about 8 miles of swift rapids. The portage was very rough on the military men, unaccustomed to such labor.

26-27: Completed the Grand Portage, passing some groves of sugar maple but, for the most part, through pine and birch. Collected on Grand Portage (exact dates uncertain): *Houstonia longifolia* (rocky banks); *Ranunculus septentrionalis* (damp woods).

28: Embarking in their canoes, they traveled three miles to Knife Falls and the Portage aux Couteaux (named from the knife-like effect of the slate on shoes and moccasins), and encamped 9 miles farther on, at the foot of "Grande Rapide." Collected on St. Louis River (exact dates & localities uncertain): *Thalictrum confine; Carex ?argyrantha* (4) (marsh).

29: Ascending the Grand Rapid and passing the Floodwood River, they arrived at the East Savannah River's mouth. Collected: *Arenaria lateriflora* (damp woods).

30: Ascended the East Savannah River to the Savannah Portage (to the West Savannah, leading to Sandy Lake). (A mile below the portage, a dry meadow with a luxuriant growth of sedge.) For most of the day, the river was so thick with mud that the canoes had to be dragged. Collected: *Carex* *tribuloides* (5) (marsh, Savannah Portage); *Glyceria borealis* (22) (marshy woods).

JULY

1: Sunday, so they rested along the Savannah Portage, on the divide between Lake Superior and the Mississippi. (Heavy forest of sugar maple, birch, and linn [basswood].) Collected: *Betula pumila* (68) ("sources of the Savannah Riv."—[today or July 2 or 3]).

2: The route through deep mud exhausted everyone and was the most fatiguing since they left home, according to Allen. Covered only 3-1/2 miles, stopping 18 miles from Sandy Lake.

3: Completing the 6-mile portage, they followed the West Savannah River to Sandy Lake, crossed the lake, and descended its outlet the 2 miles to the American Fur Company Station on the Mississippi. [See map on cover.] Collected: *Phalaris arundinacea* (wet meadow, West Savannah River).

4: Independence Day, so they celebrated and Schoolcraft councilled with the Indians. Leaving at 6:00 p.m., they ascended the Mississippi for 2 miles. (Allen took advantage of the free time today to put oars on his canoes, since his soldiers were still very awkward at using paddles and poles.)

5: Past the mouth of Swan River, 60 miles above Sandy Lake, camping 12 miles farther. ("Rich vegetation of soft maple, elm, walnut, linn, ash, &c and a luxuriant grass," reports Allen.) (Equisetums "are abundant in this northern country," observes Houghton, who was "severely annoyed by musquitoes during the whole day.")

6: Much of the countryside was burnt. Campled 2 miles below Trout River.

7: Past the mouths of Trout and Prairie Rivers, then past Peckagama [Pokegama] Falls of the Mississippi ("Wild rice first appeared just below this place," says Boutwell). Encamped at a little dry point of oak woods [Point aux Chênes] 30 miles above the falls. Collected at Falls of Peckagama: *Senecio pauperculus* (50); *Erigeron strigosus* (dry opening).

8: Sunday.

9: A winding course through a wet savannah of carex, bulrush, joint rush, and *Cinna arundinacea*. Then, instead of following the Mississippi, they took a short cut via Bogotawa [Ball Club] Lake and portaged to Little Lake Winnipeg [Little Lake Winnibigoshish]. Stopped for the night [at Turtle Portage River] at the foot of Big Lake Winnipeg, at a small trading post. (Cattle fattened on the luxuriant grass *Alopecurus;* fine garden of potatoes, tobacco, corn, squash, etc.; light oak forest.) Collected at Lake Winnipeg: *Lonicera hirsuta; Koeleria macrantha* [*K. cristata* auct.] (15) (sandy pine opening); *Delphinium virescens* (23) (sandy pine woods—[today or July 10]); *Malaxis monophylla* (damp woods).

10: Traveling the length of Lake Winnipeg, the expedition reached Cass (Upper Red Cedar) Lake and encamped near the Indian village on Grand [Star] Island. (Under cultivation about 8 acres, according to Allen, producing potatoes, corn, and vines "growing beautifully"; Boutwell wrote: "I never saw better corn, squashes, or potatoes, than I find here with Indian culture. . . . All the high land is covered with rank grass and sumach". On the way, Houghton noted: "I attempted to follow the ridges and keep pace with the canoes in a botanical excursion but finding this impossible after traveling more than a mile I again embarked.") Collected: *Corydalis aurea* (55) (Sandy openings, Grand Island); *Hordeum jubatum* (sandy pine openings); *Krigia biflora*.

11: Many of the party stayed at Cass Lake. Schoolcraft, Houghton, Allen, Johnston, Boutwell, with a few voyageurs and, as a guide, the local Indian chief, Ozawindib (Yellow Head), who had accompanied the expedition since the Bois Brule River, followed the Mississippi from Cass Lake to Lac Travers [Bemidji] and Lake Irving (named by Schoolcraft for Washington Irving). Then, taking the east fork as a short cut [via the Schoolcraft (or YellowHead) River] they passed through Marquette and La Salle Lakes, stopping at Lake Plantagenet (all three named by Schoolcraft). Collected: *Geranium bicknellii* (Lac Travers).

12: They stopped 12-15 miles from Perch Lake, at the end of a 2-mile portage, where Houghton noted "a high sandy hill covered with gray pine & rich in rare plants." Collected: *Allium cernuum* (16) (sandy pine ridges on the banks of Copper-head River [Naiwa River, above Assawa Lake; see Schoolcraft, 1834, p. 50, & 1855, pp. 236-238]).

13: (Friday) From Perch or Usaw-way (Assawa) Lake, a portage of 6 miles led west to Elk Lake (Lac la Biche) [Itasca]. The first 1 or 2 miles were a deep tamarack swamp, the remainder of the portage mostly sandy ridges of jack pine *(Pinus banksiana).* The expedition wasted little time at the object of their search, the source of the Mississippi. A flag was erected on the island, named by Allen as Schoolcraft Island, and a few plants and shells collected. They then descended the Mississippi 25 miles northward and encamped. Collected: *Carex houghtoniana* (9),[5] *Orchis rotundifolia* (portage, marsh); *Stipa spartea* (19) (sandy pine woods, Assawa River); *Silene antirrhina* (dry sandy woods, Lac La Biche "July 12"); *Ranunculus gmelinii* (42) (water, Lac La Biche); *Antennaria* sp. (82) (near Elk Lake, dry sandy pine woods).

14: A rapid descent day and night, passing Lac Travers [Bemidji] after midnight.

15: Schoolcraft and Houghton reached Cass Lake at 9:00 a.m. this Sunday; Allen, in the evening. "Red Cedar [Cass] Lk. takes its name from the red cedar which is found upon one of its islands," observed Houghton. Collected: *Mirabilis nyctaginea* (8) (dry sandy opening, Upp. Red Cedar L. [undated, presumably today or July 10 or 16]).

16: Not leaving Cass Lake by the Mississippi, they went to Moss Lake on a short portage along which Houghton notes: "I found several interesting plants." Schoolcraft (1855, p. 252) observed "more common species of pine plains" and large red pine *(Pinus resinosa).* They then followed Shiba Lake and Steamboat River to Leech Lake. Collected: *Quercus ellipsoidalis* (64) (dry sandy hill, Upper Red Cedar L.); *Lathyrus venosus* var. *intonsus* (62) (sandy pine woods, Leech Lake).

17: This day was spent at an Indian village in a western bay of Leech Lake, where Houghton vaccinated over 400 Indians, and Schoolcraft attempted to spread peace.

18: Portaging toward Crow Wing River, Houghton says: "I walked around the pond [Lake of the Island, one of 5 emptying into Leech Lake] examining the botany." Collected (Leech Lake): *Carex viridula* (6) (damp sandy shore); *Agropyron trachycaulum.* (21) (sandy pine openings). After several short portages, they came to Long [Water or Eleventh] Lake, the source of the Crow Wing River. The high ridges in the country passed over "are timbered with pine or when this has been destroyed by fire, aspen" observes Houghton.

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[5] The *Carex* which Houghton thought was a new species "allied to *C. scabrata*," collected on this historic day, was appropriately named for him: *C. houghtoniana* Torrey ex Dewey, Am. Jour. Sci. 30: 63 (1836). The label on an apparent isotype reads: "Portage to Elk Lake, source of the Mississip. July 13 - 1832. Dry sandy woods." (Later emendations of the epithet to the philologically preferable *houghtonii* have no standing under the International Code of Botanical Nomenclature.)

19: They passed through small lakes connected by streams and stopped 5 miles past Shell River (or 60 miles below Long Lake).

20: Descending "Rivière des Corbeaux" [Crow Wing River] they encamped 5-6 miles beyond the mouth of Leaf River, having covered some 80 miles. Collected: *Silene antirrhina* (dry pine opening); *Allium cernuum* (27) (sandy pine ridge); *Agastache foeniculum* (dry prairie); *Petalostemum candidum; Rudbeckia hirta* var. *serotina* (dry prairie); *Phlox pilosa* var. *fulgida* (dry prairie); *Lithospermum croceum* (dry prairie) [the latter 4 spp. from Crow Wing River but without exact date, presumably today or July 19 or 21].

21: Fifteen miles farther on, they passed the mouth of Long Prairie River and continued to the junction of the Mississippi and Crow Wing Rivers and to Baker's trading post about 10-15 miles down the Mississippi. Collected: *Lithospermum croceum* (Baker's trading house).

22: Sunday, and Houghton reports: "I walked back into the prairie & found several interesting plants. Vaccinated 17 & extracted several teeth." Collected: *Cyperus filiculmis* (14) (dry prairie above the Falls of St. Anthony); *Wulfenia bullii* (10); *Liatris cylindracea* (49); *Arabis hirsuta* ("May 22") [latter 3 all labeled from dry prairie 200 miles above Falls of St. Anthony].

23: The expedition passed Grand Rapids [near Two Rivers] and Houghton wrote: "We landed for breakfast upon a beautiful prairie of several miles in extent. . . I found several plants of great interest. The grass still being damp I determined to proceed without breakfast for two or three hours until it should dry for the purpose of drying my botanical apparatus." Past rapids at the mouth of Elk River, then past Big Falls [opposite Sauk Rapids] and Little Sac [Watab] River, covering in all 130 miles this day. Collected "above Falls of St. Anthony" (dry prairie) [no date]: *Chrysopsis bakeri* (540); *Lobelia spicata* (37); *Oenothera serrulata* (61).

24: Having passed Crow River mouth, Houghton collected at the Falls of St. Anthony [Minneapolis] (dry prairie): *Verbena stricta* (29); *Coreopsis palmata* (51); *Psoralea argophylla* (63); *Lythrum dacotanum* [*L. alatum* auct.]. The expedition continued to Fort Snelling, at the junction of St. Peter's [Minnesota] River and the Mississippi.

25: This day was spent at Fort Snelling. Collected: *Erysimum cheiranthoides* (7) (damp meadow— [today or July 24 or 26]).

26: About 50 miles after leaving Fort Snelling, they left the Mississippi and ascended Lake St. Croix for 20 miles to the north. Collected: *Juniperus communis* (Lk. St. Croix, "July 25").

27: Headed for the falls of the St. Croix River (Houghton noted butternut trees along the river). An accident to Houghton's canoe forced him to encamp before catching up with Schoolcraft. Collected: *Vernonia fasciculata* (dry sandy opening); *Lysimachia quadriflora* (28) ("St. Croix R." — [no date, presumably July 27 - Aug. 2]).

28: Having passed the Dalles of the St. Croix, they began ascending more rapids. On a portage [Taylor Falls, Minn.] Houghton "found one or two plants here of interest." Collected: *Talinum rugospermum* (11) (damp rocks, Falls of the St. Croix R.).[6]

29: Sunday, but Schoolcraft, worried because the river was falling rapidly, decided to travel. Houghton left a note for Allen, whom they had not seen since the 26th.

30: At the mouth of Snake River, Houghton collected *Euphorbia corollata* (damp openings).[7] They passed the mouth of Kettle River and Clam River.

31: The river was low, and rapids treacherous. Past Yellow River and Namakwagon [Namekagon] River, encamping 5 miles above the latter. Collected: *Alnus rugosa* (66).

AUGUST

1: Traveled only 27 miles. (River banks supported fir, spruce, pine, ash, elm, tamarack, birch, aspen, and alder; several small lakes where wild rice was just in flower.) They encamped on an Indian village site at an expansion of the river, Namakwagon Lake.

2: The party passed the mouth of Clear [Eau Claire] River, and 12 miles farther entered Upper Lake St. Croix, leaving from its head to portage to Bois Brule River. (Among the deciduous underbrush under pine on the portage Houghton "saw the Comptonia asp[l]enifolia.") Collected [today or Aug. 1]: *Glyceria canadensis* (20) (St. Croix Riv. wet. Aug. 1832).

3: Through marshy lands (tamarack, spruce, cedar) they dragged the canoes down the Brule and encamped 20 miles below Hunting River, where the stream was larger. "Mr. J[ohnston] amused himself in taking trout. He caught 50 or 60, I never before saw such quantities as this stream contains." (Houghton)

4: The canoes injured, they nevertheless managed more rapids and 4 portages, arriving at the river's mouth on Lake Superior. Collected: *Halenia deflexa; Myriophyllum exalbescens* [undated even by year; could be this month or June 22, or in 1831].

5: Spent the day (Sunday) repairing canoes.

6: Schoolcraft and Houghton left this morning, 4 days' journey ahead of Allen, and arrived at La Pointe this evening.

7: Schoolcraft and Johnston left for Sault Ste. Marie. Rev. Mr. Boutwell planned to remain with the mission at La Pointe. Houghton had promised to wait for Allen, who arrived on the 11th. Collected: *Drosera linearis* (68) (sphagnous marsh, Aug. 9); *Polygonella articulata* (damp sand, Aug. 10); *Juncus canadensis; Galeopsis tetrahit* (32).

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[6] It is of interest to note that Houghton's collection (which he called *T. teretifolium*) antedated by nearly 60 years Holzinger's collection at St. Croix Falls, the only station known to Holzinger besides the type locality at Trempealeau Prairie, Wisconsin. (See original description in *Asa Gray Bull.* 7:115-117. 1899. [Note also comments in the same journal 8: 37. 1900.])

[7] The back of Houghton's original label reads: "The root is a celebrated Indian cathartic & is known to the Fr. voyageurs as the medicine La Grande Riviere; probably in allusion to its growing near the Mississippi." (See also Houghton in Mason, 1958, p. 276.)

12: Houghton and Allen set out, and encamped at the foot of the Porcupine Mountains. ("Behind at a distance of ten feet was a thick forest of aspen pine & maple.")

13: Arriving at the mouth of the Ontonagon River, Houghton and Allen found no Indian to guide them to the Copper Rock, so went off on their own.

14: They reached the forks of the Ontonagon River, 38 miles from its mouth, and set out on foot. (Large sugar maple, birch, hemlock, oak, leatherwood.) Encamped "in a forest of heavy pine timber."

15: Found the Copper Rock and began to return, camping 15 miles below the forks of the river.

16: Continued down the river and along Lake Superior, encamping a few miles above Rivière à Misère [Misery River].

17: Sailed past the Keweenaw Portage and camped 17 miles beyond. (Found many red raspberries [probably *Rubus parviflorus].)*

18: Near Keweenaw Point, they encamped at Little Marais, finding "the rasp[b]erry (Rubus perviflorus) in fruit." Collected: *Artemisia canadensis* (rocky shore, Keweena Pt.).

19: Passing [Traverse] Island and the Huron Islands, they camped at the mouth of the Huron River, having traveled over 100 miles today.

20: Landed for a short time at Presque Isle to collect minerals; then went on, camping at Rivière du Mort [Dead River]. Collected: *Lobelia kalmii* (36) (rocky shore, Presque Isle).

21: Passing behind Grand Island, they reached within a mile of Miner's River, but heavy wind and weather sent them back to Grand Island.

22: Heavy gales forced them to remain in camp. Indians visited them and presented them with blueberries. (Back in the island, cedar swamp with ridges supporting beech and maple.)

23: Passed Pictured Rocks, Grand Sable, and Grand Marais, but the wind forced them to stop at Whitefish Point.

24: The wind was still a gale, and they were forced to spend the day at Shelldrake River, 30 miles from Sault Ste. Marie.

25: Missing their course, they went into Tonquoimenon [Tahquamenon] Bay. Then, passing Point Iroquois, they reached Sault Ste. Marie at 5:00 p.m. The expedition was over.

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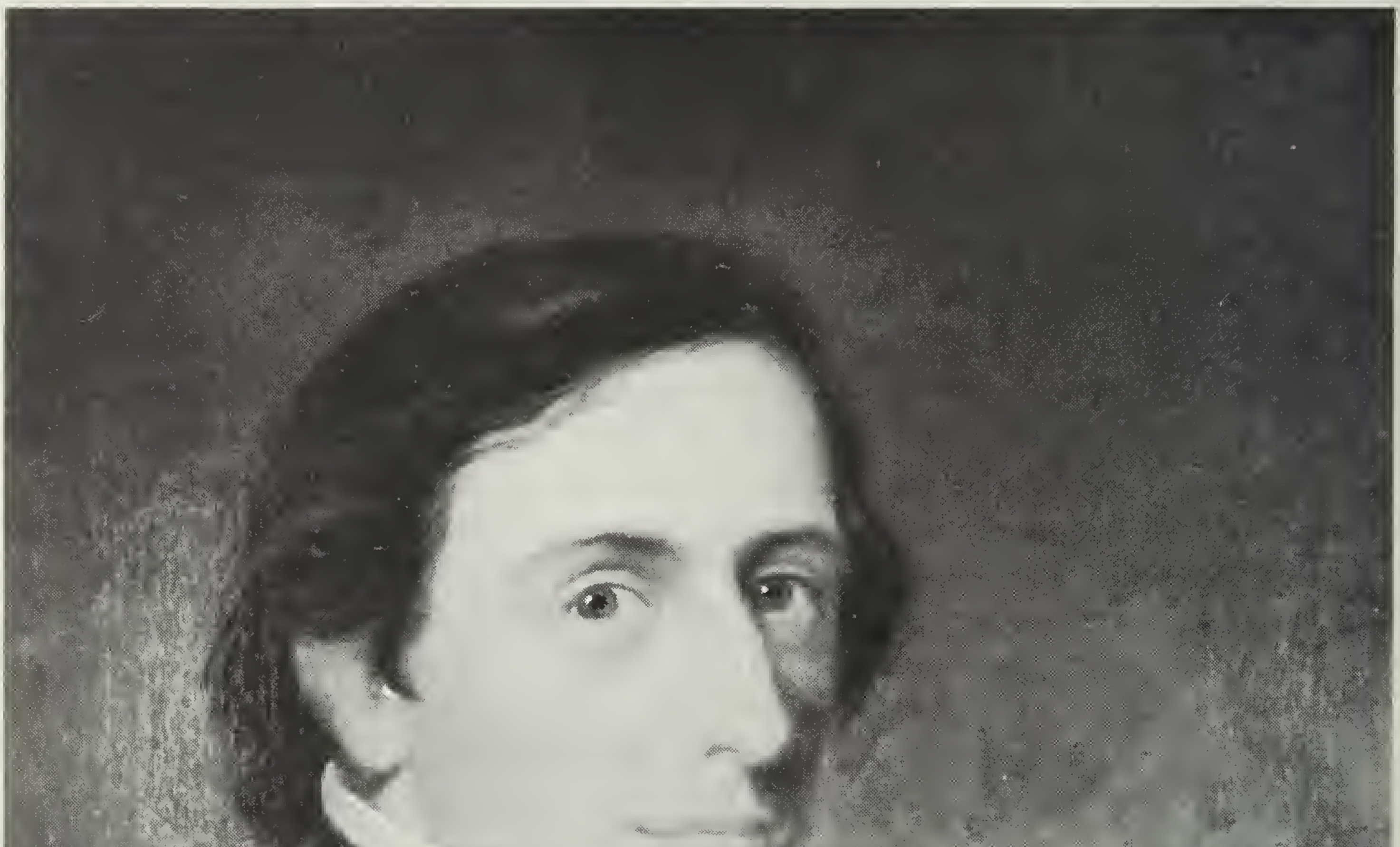

Douglass Houghton (1809-1845), State Geologist of Michigan 1837-1845; Mayor of Detroit 1842-1843; Professor of Geology, Mineralogy, and Chemistry in the University of Michigan 1838-1845. In 1850 Alvah Bradish painted this portrait, which hangs in the Michigan Historical Collections, Ann Arbor.

A LOOK AT CONSERVATION[1]

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When I was a little girl my father came back one night from our village and said that President McKinley had been shot. I, of course, was badly frightened, and to calm me down my father told me all about the wonderful man who would be our president, Theodore Roosevelt. He said Roosevelt had lived in a cabin all alone, 'way out west, with the birds and cattle, and that he knew so much about our Natural Resources. None of us, as I remember it, had ever heard the term "Conservation." But as soon as Theodore Roosevelt got going we heard a lot about "economy of natural resources."

We all knew "Teddy," as everyone called him, to be a fighter. He was a man of action. Gifford Pinchot, of Pennsylvania, was Chief of the Forest Service and we had a farm woods so I knew about him. My father said the population was growing by leaps and bounds and we would need all the woodlots. They would slow the water from running off. Besides, the farmers for miles around came to our beautiful river bank for picnics; and while none of us had ever heard of a State Park, my father said we would need lots of woods for people to spend their off days in. In fact my father thought we would need everything God had given us to take care of all the needs of all the people in the future.

Sixty years or so later I can make the same observation. 870,000,000 people were in the world as the 19th century ended. Then industrial expansion, commercial extension, faster food transport, advances in medical sciences and especially sanitation (controls of pestilences and plagues making lower death rates and lower infant mortality), gave us in the next 100 years double that number—about 1,600 million. Since 1900 we have increased at an even faster rate. In another fifty years we had a total of 2,400,000,000, so that if we go ahead without major military conflicts, we probably will have about 3,600,000,000 as this century ends. Some countries are in serious programs of population limitations. If we, here in America, do not help ourselves with considerable intelligence we may find we have not used what God gave us wisely enough for all the needs of all the people.

I hardly need tell you that some of our resources are irreplaceable, such as minerals, lands in natural condition, wilderness. Others are replaceable only with a lot of management, maintenance, scientific control, such as forests, soils, water, animals. Air and rain are about the only inexhaustible natural resources. If you want to read more about this, get Shirley Allen's book and read pages 2-6.

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[1] A lecture presented by request October 9, 1961, for the Landscape Design Study Course sponsored by the Federated Garden Clubs of Michigan, Inc., in cooperation with the Department of Landscape Architecture and the Extension Service, University of Michigan.

Conservation has come about--shall we say been forced upon us--because of people and the way they use resources. Aldo Leopold makes us a nice definition toward the end of his book (p. 207) when he says "Conservation is a state of harmony between men and land." Here he uses land in its broadest sense--to understand how broadly you should read his *Sand County Almanac*, not just once, but several times. It was too bad we lost Aldo so soon. He had a great impact upon the conservation thinking of his time. But other thinkers have had other good definitions. Samuel T. Dana, Dean Emeritus of our University of Michigan School of Natural Resources, follows Ernest S. Griffith in the book of essays, *Perspectives on Conservation* (1958), by writing: "Dr. Griffith . . . is to be congratulated on his wisdom in avoiding any definition of "conservation"--either his own, or someone else's. . . . I should like, however, to indicate what I conceive to be the objective of conservation both as a philosophy and a program of action: namely, to bring about the widespread adoption of policies and practices that will promote the public interest in all matters relating to the management and utilization of natural resources." By reading on with him you will soon see he is well aware that management and utilization cannot be wise without scientific research and much planning. In fact, he goes beyond this, for in his last sentence he says that the progress of the next fifty years depends upon our ability to effect the union of science and conscience. Research and planning are not together enough. Aldo Leopold quotes Robinson's injunction to Tristram:

> Whether you will or not
> You are a King, Tristram, for you are one
> Of the time-tested few that leave the world,
> When they are gone, not the place it was.
> Mark what you leave

Theodore Roosevelt was the man who called the conference of state governors in 1908, and thus started what has turned into Conservation as we know it. Probably, in fairness, we should say he could not have done this except for some things that had been happening before. The American Association for the Advancement of Science had committees as early as 1873 concerned about the preservation of timber. The American Forestry Association was active too. The Congress had passed acts in 1891 for forest reserves. Lands were pertained as great scenic assets: Hot Springs as early as 1832; Yellowstone, 1872; Yosemite, Sequoia, and General Grant Parks, in 1890. Laws had been passed about mining. A Bureau of Forestry and an irrigation division of the Geological Survey were set up on the Federal level in the late 1800's.

Roosevelt's conference was the first on such a high government plane. Not very many of our presidents have taken such a personal interest in resource management. Sometimes our Congress has been the source of some important development in this direction. Besides all the governors at this conference, there were other very important people. Shirley Allen says that "Members of the Senate and the House of Representatives, the judges of the U.S. Supreme Court, representatives of the important scientific societies, members of the Inland Waterways Commission, and certain prominent citizens" drew up a "Declaration of Principles" which was forceful and authoritative. But there were two things which happened afterwards that may have been of even more importance. A large group was appointed to a National Conservation Commission; this in December (the Conference had been in May) brought back to the governors an inventory of the country's natural resources. This inventory was used later by Roosevelt as a basis for withdrawals of vast areas of public lands until they might be dedicated as timber, mineral, or water reserves. The sad part of it was that the planning which might have followed such an inventory failed to come about because Congress was apathetic to a request by the Commission for $25,000.

Roosevelt, however, was not to be easily stopped. He called a North American Conservation Conference in 1909, and there problems were considered on an international scale. This meeting proposed a world conference to be called later at the Hague. But President Taft was not Roosevelt! This meeting, which could have meant so much, never was pushed to fruition. Later, the United Nations did do something about it in 1949 and this, at least, got scientific workers together. It should be mentioned that Gifford Pinchot died that year, never having given up the idea of a world conservation meeting.

The second important thing that came out of the 1908 conference was that shortly thereafter in 41 states some sort or other of conservation agencies were officially set up. Michigan was not in the forefront of this development. We were at that time changing governors too often. Alexander J. Groesbeck was in office 1921 through 1926, and during this time elderly John Baird was officially in Lansing trying to save the moose herd on Isle Royale. D. H. Day State Park came to us as a gift about this time, and Ludington was pushed in as a State Park by interested citizens. The Conservation Department was officially established in 1921, the Director being appointed by the governor. In 1927, the sportsman governor, Fred Green, of Ionia, called a group of interested citizens together, meeting at his out-of-doors quiet spot. He insisted that the program be as much removed as possible from political implications, and the law was changed so that the Director of Conservation was appointed by the Conservation Commission, which had the responsibility for direction of the program. The seven non-paid members of the Conservation Commission each serve for six years, two being appointed at a time by the governor. All have reimbursement for expenses incurred in performance of duty. Commissioner Rahilly of Newberry, who recently retired, served twenty-seven years without ever having taken advantage of his expense account. After knowing many of these commissioners through the years, my thought is that they have given outstanding service, often at considerable personal sacrifice, to do this job for all of us. They surely deserve our thanks. They have usually been appointed on a geographical basis but there is now a law by which two must come from the Upper Peninsula. The appointments have usually been distributed politically, too; Governor Williams, who had the opportunity to appoint more than others, appointing some Republicans.

The Conservation Commission meets once a month, usually the second Friday morning in formal session. Thursday afternoon before this they hold an informal session where any citizens or groups may make statements about any current problems. Of late, the meetings are being held about the State, the feeling being that this gives a better chance for more persons to participate, especially on Thursday. The various towns where meetings have been held recently have gone "all out" to take the Commissioners about their environs to see local projects. Usually quite a number of newspapers and other communication media follow the schedules. Since a number of technical Departmental personnel usually are also needed, entertaining the Conservation Commission has become quite a sizeable local event.

The headquarters of the Department of Conservation are located on the third floor of the Stevens T. Mason Building in Lansing, across from the Civic Center. Out in the State there are regional headquarters (all that I know of are plain white clapboard structures trimmed with green and have prominent signs in front of them). About 1800 persons have been working for this Department. Now there is too little money, the ranks are being thinned, and our services are suffering.

I have not much time here to describe the period from 1908 until the present. There has been a steady progress. Conservation goes beyond research, planning and conscience. Since it involves people, we have a difference of opinions and these sometimes turn into conflicts of interest. Governmental agencies are particularly aware of this, indeed may sometimes take a hand in presenting the facts which may prevent wrangles or help shape public opinion. These governmental agencies deal with people en masse and thus have been forced to come by some basic stated policies which can be set down in black and white for all to go by. This has taken a lot of doing, covers thousands of committee meetings, conferences to achieve a meeting of minds--all sorts of minds. Due to commercial development and private enterprise, the government has been forced deeper and deeper into the picture. What eventually came out of it all was a policy of multiple use, a concept probably going back as far as 1905 or 1910.

This concept was not understood very well nor clearly defined at once, and really came into use much later among trained conservationists. The most thoughtful ones even then have scarcely felt it a panacea. We do have two outstanding examples of this policy in action. There was great unemployment and some financial distress as Franklin Delano Roosevelt came into his term of office. Great clouds of flying sand had also blown out of the southwestern Dust Bowl. I remember being present at a National Convention of Federated Garden Clubs in Grand Rapids when the great cartoonist ''Ding'' Darling gave the major address and made a dramatic plea for something to be done about this by our national government. The President was anxious for a way of getting youths into better, more hopeful, healthful environments, but had not seen just how this could be quickly and effectively accomplished. One day President Roosevelt was told that there was a man from Michigan in Washington who could probably help him do this—our Conservation Director, P. J. Hoffmaster, who was there on business. Before Hoffmaster left for home, the first blueprints had been drawn for the Civilian Conservation Corps. Very soon thereafter, camps sprang up in places wherever out-of-door work projects needed doing, and 200 enrollees to a camp lived and worked under army supervision. About two and a half million young men were so occupied, and accomplished a great deal that was good. Besides any contribution to conservation, they had improved their education and skills, improved their health, reduced delinquencies, and later used their training in industrial employment. For the first time there had been great emphasis on conservation of human powers, as well as on natural resources. But not the least of the benefits was the generous education it gave the public; they read every word in newspapers, trudged around to see what was going on, and asked of everyone a trillion questions!

The second outstanding example of multiple use was of a different sort. The establishment of the Tennessee Valley Authority also came about in 1933. This was an attempt to readjust the economy of a great river valley and behind it, with the President, was Senator George Norris. Norris was a towering conservationist, and the project attracted the widest attention all over the world. It took recreation into real account and John Ise in his book *Our National Park Policy, A Critical History* (1961), ranks this endeavor along with the establishment of our National Parks as the two land policies the United States has originated of world-wide significance. Again, we must say that one of the valuable dividends resulting from this adventure was in calling conservation and multiple use to the attention of a wide public. Water power, irrigation, flood control, navigation, avoidance of pollution, watershed management, industrial uses, and recreation have now become inter-related in the public mind; and rivers, hereafter, have a unity of uses they could hardly have come by in any other way. In a much smaller way our own Conservation

Department did something a little like this on the Rifle River and others in Michigan.

While these things were going on, another factor was developing. We were not only increasing in population by leaps and bounds; we were raising our standards of living. The buggy my father rode in was not good enough for me, nor the road he drove along. I go, in my little green Fairlane, about 18,000 miles a year, in the pursuit of my activities—a distance my father would have thought fantastic. I eat my lunch, not on a farmer's river bank, but in a State Park next to folks from Florida and California and all the spots between them. If I camp in such a park, my outfit might easily have cost me $2,000 or $3,000, and I probably have an electric stove and electric lights to read by. I want a laundromat close, to keep my play clothes clean. Since most of my friends are also camping in the Park, it has become a "cramp" grounds, with a rope at the gate by noontime. Even if we do talk "multiple use," has God given us enough for all the wants of all the people?

We have, therefore, talked lately, about "the greatest use for the greatest number over the longest period of time." This implies that some people are not going to get what they want, or in the supply that they want it. But conservation officialdom now pretty largely accepts this. This policy seems to be doing reasonably well—at least in spots--at making a workable philosophy. Let us say that higher education has provided us the scientists and researchers who can give us the facts. Maybe they are even on the way to giving us, too, the planners--some, we hope, with perception and training in conservation thought. John Ormsbee Simonds, the landscape architect from Pittsburgh, has a choice page at the beginning of his book. He is apparently a little shocked—and I am too—that so few landscape architects have real appreciation of natural history values. We must be concerned with what our planners do to—or put upon—the lands they deal with, but you and I as conservationists must be even more greatly concerned with what is present before they plan the uses of it.

Yes! We must study our own needs more, knowing honestly why we need what we ask for. We must be willing to defend intelligently our viewpoint, willing to bend over backwards to see that others understand us. To achieve the greatest good for the greatest number over the longest period of time we shall have to coordinate efforts, cooperate with one another objectively, perhaps at times compromise, even if it hurts at first. It is a noble experiment but it better not fail.

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CULTURE OF *CASTILLEJA COCCINEA* (INDIAN PAINT-BRUSH), A ROOT-PARASITIC FLOWERING PLANT[1]

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Scarlet Indian paint-brush, *Castilleja coccinea* (L.) Spreng. (Scrophulariaceae), is a flowering plant which parasitizes the roots of other vascular plants. The species in Michigan is locally common close to the shores of the northern lower peninsula. The plants are chlorophyllous and presumably photosynthetic, but their maturation typically depends on their successfully penetrating foreign roots. Roots of the parasites produce so-called haustoria, structures which adhere to nearby roots and lyse or force access to the vascular elements (Solms-Laubach, 1867). Root-parasitism has been studied in Europe since the late 1800's in genera related to *Castilleja,* but is still poorly understood. The parasite is suspected of extracting water, mineral nutrients, some food materials, and perhaps phytohormones from its host (Hărtel, 1959; Rogers and Nelson, 1959), but the evidence is good only for water and mineral nutrients.

Pot-culture of *Castilleja* has been largely unsuccessful, apparently because hosts have not been provided. But, given suitable hosts, *Castilleja coccinea* can be grown readily in flower-pots in a greenhouse or even indoors if enough light is available (fig. 1). Culture of the genus is valuable on two counts. First, extreme variation in the morphology of *Castilleja* species has raised many taxonomic problems. Pot-culture under uniform conditions would undoubtedly aid in studies of variation and species limits. Second, *Castilleja* is of interest to ecologists studying plant interactions. Because we usually think of parasitism as food transfer, obligate parasitism in a green plant seems contradictory, and study of such an interaction could add to our understanding of more extreme parasitism.

Preparation of the parasite seed and the hosts is time-consuming but demands no unusual equipment. Seed is collected by gathering ripe capsules in a polyethylene bag. The capsules are later broken open with forceps over a bowl covered with a piece of ordinary screen. The screen excludes plant debris but allows the seeds to fall into the bowl. Each capsule produces hundreds of seeds, and even a partly-dehisced capsule yields many. The seeds will germinate at the time of capsule dehiscence and in the absence of a host. They can be stored dry in a refrigerator for over a year.

Greenhouse culture and field studies reveal that the parasite has a wide host-range, and in nature attacks most of the vascular plants

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[1] This study was supported in part by National Science Foundation grant G-13991.

around it. However, some hosts are apparently 'better' than others. The suitability of a host may depend more on its root distribution than anything else, and good hosts are best found simply by trial and error. Three hosts promoting rapid growth of the parasite are *Lactuca canadensis, Chrysanthemum leucanthemum* var. *pinnatifidum,* and *Fragaria virginiana.* Potential hosts are dug up and potted in the field, brought into a greenhouse or indoors, and for about a week allowed to regenerate their damaged roots.

A four-inch pot is plugged at the bottom with a small square of blotter paper and nearly filled with sand. The sand is tamped lightly into the pot to form a smooth surface. The host is washed free of soil and debris, and its roots are spread out on the surface of the sand. The roots are then covered with another quarter-inch of sand, and the pot is watered generously. Several hundred *Castilleja coccinea* seeds are later sprinkled evenly over the surface. The pot is placed in a greenhouse tray in half-inch-deep water. Germination typically occurs in three days.

The seedlings grow vigorously, producing cotyledons and many root hairs. The hypocotyl continues to grow, but the epicotyl remains dormant until host-contact is made. In fact, a four-month-old seedling which has not penetrated a host root looks much like a four-day-old seedling. Apparently host-contact is by chance—the roots of parasite seedlings grown under glass are not visibly attracted to nearby foreign roots. After host-contact is made, usually within two weeks of germination, the foliage leaves expand rapidly, producing in three or four months a leafy rosette 2-5 cm in diameter. After cold-treatment for a month or two, the rosette produces a flowering shoot. The margins of the rosette leaves are entire, but the plant produces 'mittens,' lobed leaves, during the growth of the flowering shoot (fig. 2). Oddly enough, host-contact is required for initial growth of the rosette, but a mature rosette dug up, washed free of foreign roots, and potted alone will flower.

For observation of the haustoria, the host and parasite are simply dumped from the pot and their tangled roots carefully washed free of sand in a bucket of water. The haustoria are fragile, and pull loose unless handled gently. They are best seen under a dissecting microscope because of their small size. If kept moist and handled carefully, a parasite and its host can be replanted successfully after being examined for haustoria.

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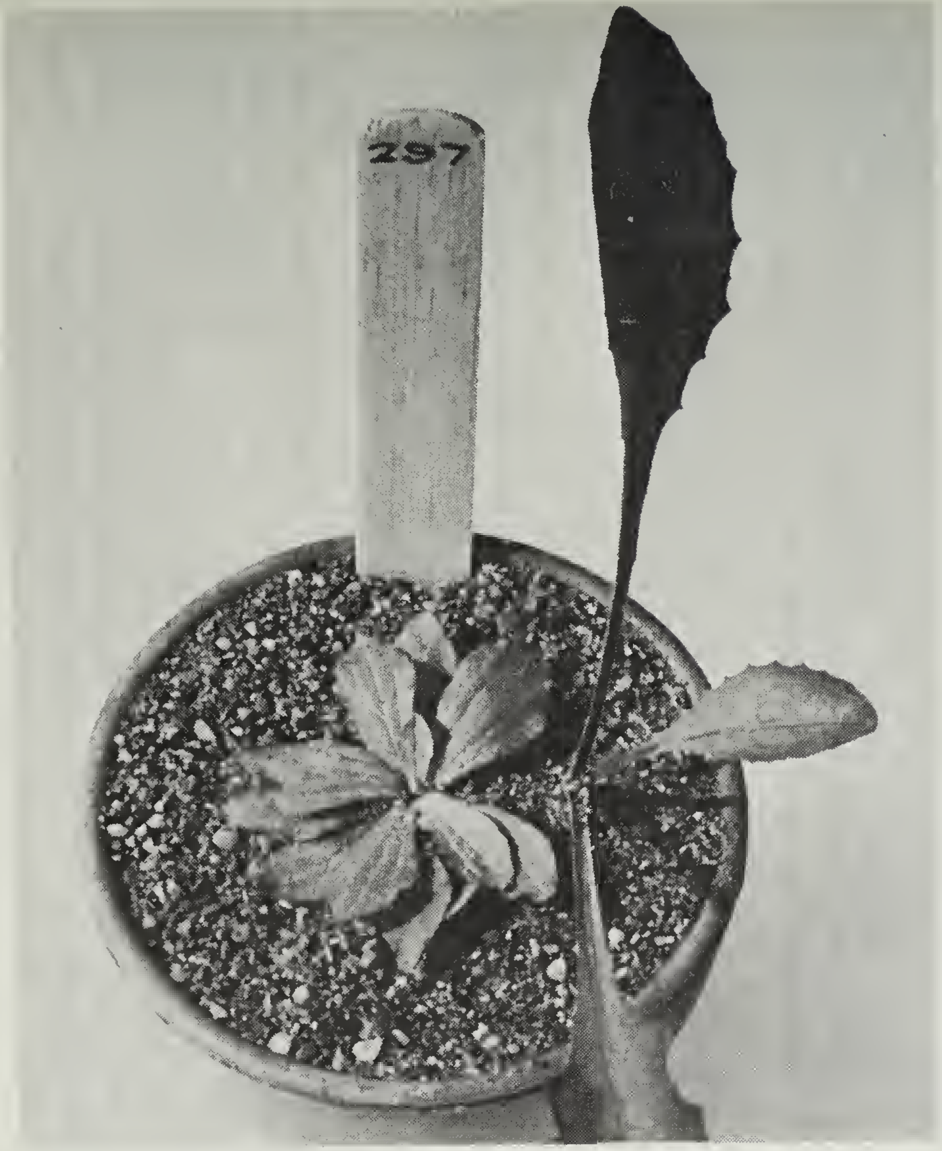

Fig. 1. A mature rosette of *Castilleja coccinea* parasitic on a young rosette of *Lactuca canadensis*. The *Lactuca* was transplanted from the field, but the *Castilleja* grown from seed. At this stage of development, the *Castilleja* would flower if pulled free of its host and potted separately.

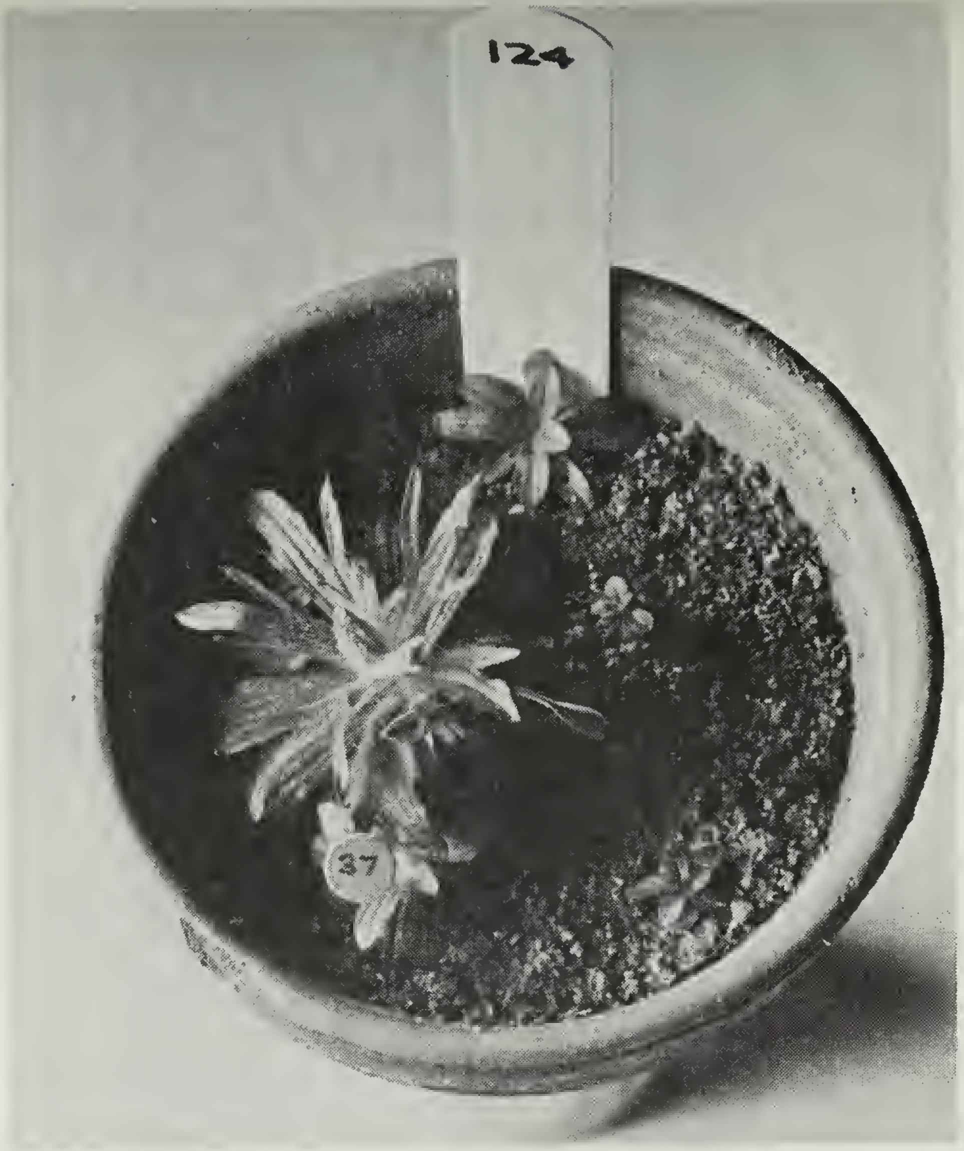

Fig. 2. Several rosettes of *Castilleja coccinea* parasitic on *Krigia biflora*, which has died back to only two leaves in the center of the pot. All the rosettes are the same age, but most have suffered inadequate host-contact. The largest rosette is 'bolting,' beginning to produce a flowering stalk with deeply-lobed 'double-mitten' leaves.

A New Combination in the *Scirpus cyperinus* Complex

Scirpus cyperinus var. *pedicellatus* (Fern.) Schuyler, comb. nov.
Scirpus pedicellatus Fern., Rhodora 2: 16. 1900.
Eriophorum cyperinum var. *pedicellatum* (Fern.) Farwell, Rep. Mich. Acad. 21: 360. 1920.
Scirpus cyperinus var. *laxus* (Gray) Beetle, Am. Jour. Bot. 33: 662. 1946. [as to plant described, not *S. eriophorum* var. *laxus* Gray, Man., ed. 2, p. 501 (1856), which applies to *S. rubricosus* Fern. The latter, if treated as a variety, should therefore be called *S. cyperinus* var. *laxus*.]

Scirpus pedicellatus var. *pullus* Fern. and *S. atrocinctus* var. *grandis* Fern. (Rhodora 2: 17, 1900) apply to plants which are intermediate between the well defined varieties of *S. cyperinus*, and these epithets should not be taken up for typical var. *pedicellatus*.

In Michigan *S. cyperinus* var. *pedicellatus* is quite rare and the only specimen known by the author which appears to be typical is the following: Baraga Co.: near L'Anse, Sept. 7, 1916, *C. K. Dodge* (MICH). This locality is about 75 miles north-northeast of the nearest locality where this sedge has been collected in Wisconsin: Oneida Co.: Three Lakes, Aug. 10, 1930, *N. G. Smith 199* (WIS).

—Alfred E. Schuyler, Department of Botany,
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Editorial Notes

The Missouri Botanical Garden has announced that the Ninth Annual Symposium on Systematics will be held Friday and Saturday, October 19-20, 1962, in St. Louis. The subject will be "Quantitative Systematics." This symposium, which each year brings together research workers and advanced students in zoology and botany to discuss common problems of systematics, is supported by a grant from the National Science Foundation.

The Michigan Botanical Club lost a good friend and member June 7, 1962, in the death of Monroe County's representative in the State Legislature, William C. Sterling. (Sterling State Park is named for his family.)

Michigan readers who may be unfamiliar with the author of the charming essay which we are honored to present on the following pages will enjoy it nonetheless. However, we might mention that Arthur Stanley Pease retired in 1950 as Pope Professor of the Latin Language and Literature at Harvard University, where he had joined the faculty of his alma mater (A.B. '02; Ph. D. '05) in 1932, after five years as president of Amherst College. Author of a 350-page flora of Coös County, New Hampshire, Professor Pease is perhaps best known to modern botanists as Fernald's "constant adviser" regarding meanings of scientific names in *Gray's Manual*. In 1933 he collected on the Slate Islands and other sites along the north shore of Lake Superior, and in 1935 he was Fernald's companion to the south shore, a trip which prompted Fernald's writing on "Critical Plants of the Upper Great Lakes Region of Ontario and Michigan" (Contr. Gray Herb. 108. 1935). The trip described in this issue was made in June of 1921.

NORTH OF THE SOO

Arthur Stanley Pease
Randolph, New Hampshire

The busy locks at the Michigan Sault Ste. Marie, with their ceaseless succession of long ore boats noiselessly transporting the iron of the Minnesota ranges to feed the hungry smelters of Ohio and Pennsylvania, I left behind, one June morning, four decades ago, and crossed on the ferry to the less pretentious Canadian town of the same name, where at nine o'clock I entrained on the Algoma Central and Hudson Bay Railway, upon a train running northward thrice weekly. The one or two passenger cars seemed largely filled with mining prospectors, for the gold mines of the Algoma region were then booming, and at almost every station, as the train wound its sinuous way through the barren hills of the desolate Canadian Shield, some of these adventurers would drop off to seek their fortunes. One was conscious of a certain air of expectancy on the part of most of the passengers, almost like that of collegiate spectators bound for a boat-race at New London. Rocky ledges, burned over, no doubt, not many years before, were interspersed with the green oases of little spruce bogs or the blue of small rockbound lakes. Up and up we climbed, crossing the Montreal River just above its fine falls, and getting occasional views of the waters of Lake Superior far away and below.

At Mile 103 (from the Soo) I left the train, and knapsack on back, walked with a few other passengers down a rough road for four miles to the lake shore at Agawa Bay. Just how I had learned of Dave Bursineau, for whose hospitality I was headed, I have completely forgotten, but we came at last to his storey-and-a-half cabin, some rods back from the lake, built of hewn red pine logs, with plastered chinks. Between it and the lake were the traces of a post of the Hudson Bay Company (more precisely the Company of Adventurers of England Trading into Hudson's Bay), abandoned some twenty-three years before. Beyond that was the beach, facing the sunset, bordered at a little distance to right and to left by stern and hardly passable cliffs. My companions on the way down separated to two other little cabins which completed this village of Agawa Bay.

Mme. Bursineau's father, a full-blooded Indian, was one of the little household, and as he and I stood by the lake I thought it a good opportunity to test the accuracy of Longfellow, and so asked him the Indian name of the lake before us. He instantly replied "Ojibway Gitchy Gummi," so Longfellow was upheld. I further learned from him that their nearest neighbors along the lake in either direction were about twenty-five miles distant; also that the winter temperature sometimes reached forty degrees below zero. I had no need to ask him whether black flies and mosquitoes were abundant in the summer, for their advance guards were already busy.

I recall nothing of what we had to eat in this secluded spot, but there was certainly nothing so superlative as the fried whitefish livers which an attentive landlady at Ontonagon, Michigan, on another trip, set forth for a companion and myself, a dish possessing all the virtues of fried oysters and sweetbreads combined, with its own particular qualities super-added.

The Agawa River empties nearby into the lake, filled, like the lake itself, with the clear, almost icy water so characteristic of Lake Superior, and a mile or two up the river, at Burnt Rock Pool, falls over high cliffs in a wild gorge, said to have been described by Stewart Edward White in his book, *The Forest.*

The night I passed in simple but clean quarters, on a cot in the attic of the cabin, with enough chinks in the plaster to keep the air within reasonably fresh, and the next day was spent partly along the beach and partly in a second trip to the river and falls, for one who stops here between trains must make a stay of two days, and other accessible spots were very few.

On the third day my host drove me up the rough road to the railway at the little division-point of Frater (why so called I did not discover; perhaps all folk in these hospitable woods are conceived as brethren), and the train wound its way for ten miles or so through the deep and striking canyon of the Agawa, walled on both sides by high and steep cliffs. This was followed by more barrens, burns, and jackpine trees; indeed, in the region of the Canadian Shield that formula of barrens, burns, and jackpines will usually apply. As we passed one of the countless bogs a big moose, unexpectedly embarrassed by the triweekly train, was seen close by the track, his legs much involved in the mucky soil.

About quarter past seven the train drew up for the night at Franz—locally pronounced *Frawns*—where our line intersected the longer established transcontinental line of the Canadian Pacific. The tiny village of a few houses of section men, a veritable metropolis as compared with Agawa Bay, was dominated by the very modest little Franz Hotel, where it was without question by officials, townsfolk, and passengers assumed that we would spend the night. Passengers were very few but bed-rooms fewer. The proprietor, a breezy and enthusiastic Scotsman named Neil McDougall, selected as my room-mate for the night a man with whom I had conversed on the train, Mr. Raynor of Ottawa, an inspector of seeds for the provincial government, and I had no reason to criticize his selection. Before dark—and dark comes late on June the twenty-second as far north as central Newfoundland—I strolled out in the only places in which to walk, namely the shoulders of the track of the Canadian Pacific. East of the crossing it passed through cuttings now appropriated by large clumps of the Fragrant Fern—which in the east we consider a rarity of some note; westward the rails, still glimmering in the twilight, stretched away into apparently limitless bogs. Everywhere the air was noticeably invigorating, like the atmosphere of the Engadine at Pontresina, and a friend who some years later spent a night at Franz, unaware of the fact that I had ever been there, told me how he had been struck by its bracing quality. Perhaps it is because the west winds blow over Lake Superior and then over miles of unbroken forest before reaching this spot.

Next morning at 8:30 Mr. Raynor, four other passengers, and I boarded the mixed train on the Algoma Central, which ran farther north but twice a week each way. Several carloads of steel rails furnished the important part of the cargo. I had worried a little where we should get fed in the middle of the day, but the conductor assured me that lunch would be served at Mile 229. I was still a little suspicious about the culinary propsects of such a mile-sign. As we advanced we left the region of the Canadian Shield and passed into the richer soil of the Clay Belt, bare ledges being succeeded by swampy woods and jackpines replaced by arbor-vitae bogs. In the midst of one of these bogs lies Mile 229, where the train stopped and passengers and crew all got out. In a tiny clearing in the forest beside the track were two or three neat looking log-cabins, with a little painted white picket fence in front of the nearest one. Into this cabin we were shepherded by the conductor, and I was surprised to find myself instantly transported into a city office. Here were filing cases, typewriters (both feminine and neuter), and all the paraphernalia of a business concern, for this turned out to be the office of the Lake Superior Paper Company. We passed through the first cabin into one behind, and there, outspread on tables in large pots and plates, were steaming hot foods of several sorts, excellently cooked. One helped himself on tin plates, ate all he could (urged by the cook to take a second helping), and paid fifty cents. I have often found a meal costing four times as much was not a fourth as good.

When we had put away the desire for food and drink we continued our journey, till at Hearst we intersected the line of the Grand Trunk Pacific Railway, as it was then called, built only half a dozen years before. This was—and is—the terminus of the Algoma Central, Hudson Bay being now reached by another line.

At Hearst, after vainly attempting to secure quarters over the Grand Trunk station, which we had heard was the most elite spot in town, Mr. Raynor and I put up at the Windsor Hotel, a two-storey, unclapboarded, unpainted, flat-roofed structure, not readily suggestive of Windsor Castle, in emulation of which it may have been named. At least it was clean, and one of our fellow-passengers on the train, whom we met in the town, expressed his envy of our superior quarters, since the beds in his hostelry were peopled by that small but very lively personnel which we sometimes associate with the frontier. Of one such hotel it was once remarked that it had burnt down "with great loss of life."

And Hearst was the frontier. Two churches, Roman Catholic and Anglican, the priest's house, and the railroad station seemed to be the only painted structures. Wooden sidewalks, treacherous where they crossed the deeper gullies, and the life of the town directed toward—rather than apologetically away from—the railroad tracks—these and other features convinced us that we were near the edge of civilization, and when next day at Mattice, a station farther east, I saw inhabited Indian tepees beside the railway, I could but contrast the indigenous and the exotic. In the town of Hearst the very gutters of the main street yielded *Lonicera involucrata*, a honeysuckle which in the East is one of the novel rarities of the Gaspé Peninsula.

After settling at the Windsor I accompanied Mr. Raynor as he went upon his business of seed inspecting. We visited all stores in the town where agricultural seeds were for sale in bulk, and from each bag he took a small handful, spread the seeds out thinly in his hand, and counted the number of weed seeds. If these were more than a certain percentage he condemned the lot. I was sorry next day to part at Cochrane from so informing and discriminating a fellow-traveller.

Eastward from Cochrane the frontier aspect of the country increased. Repeated fires were blazing, set to burn off the thick forest of small spruces to make clearings for settlements, where sometimes whole parishes from eastern Canada had come in, with church and priest, to settle in this richer and less crowded Clay Belt. After the trees had been charred their trunks and their shallow roots were pulled up and again burned in piles. I thought the waste of all this valuable pulp-wood a disgrace, but it was pointed out to me that the trees were much reduced in size (for some of the time we were only about 150 miles from James Bay), so that it did not pay to transport them by rail, and that the local rivers all flowed, not toward pulp mills, but to the north where there were no mills to use the logs. All the same, it was a wasteful method, even though our own ancestors in the states may often have used it. Occasionally Nature took her revenge, for as we passed Lake Abitibi great fires on the farther shore had spread out of control, and columns of flame were rising to the sky, while nearer at hand, as we passed through the Quebec village of Natagan, we found the whole town, church and railroad station alike, still smouldering in ashes.

During the next daylight we reached the St. Maurice valley, and after a time the city of Quebec, the loadstone for large numbers of pioneers and backwoodsmen, and after the new and fresh frontier we had a chance to contrast one of the oldest looking cities of the New World.

The spaces I had covered were but tiny, compared with that vast Canadian northland, of small, thick evergreen forest, glacially smoothed ledges, bog-bordered lakes, monotonous muskeg, and barren tundra, cloven by northward hurrying streams, populated by black flies and mosquitoes innumerable, and made famous by John Buchan and others.

Where the north really begins depends upon how far you are going, but for me I think it may not unfairly start at the Soo.

CAREX GRAYII IN THE WESTERN UPPER PENINSULA OF MICHIGAN [1]

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The distribution of *Carex grayii* Carey in North America is given by Gleason in the *Illustrated Flora of the Northeastern United States and Adjacent Canada* (1952) as "Moist woodlands, Vt. to Wis., s. to Ga. and Mo.", and by Fernald in *Gray's Manual of Botany* (1950) as "Calcareous meadows and alluvial woods, sw. Que. to Ia., s. to w. N.E., L.I., n. N.J., Pa., O., Ind., Ill. and n. Ark.". Gleason does not recognize the variety *hispidula* Gray, whereas Fernald gives the following distribution: "Ga. to Miss. and Mo., n. to centr. Ct., e. N.Y., O., s. Mich., Ind. and Ill., apparently the only var. from se. Va. to Miss."

Hermann (1941) in a monograph on the genus *Carex* in Michigan, reported *C. Grayii* from 15 southern counties: Berrien, Genesee, Gratiot, Ingham, Ionia, Kalamazoo, Kent, Macomb, Midland, Monroe, Saginaw, St. Clair, Washtenaw, Wayne, and Van Buren. All the counties are located south of a line drawn approximately southwest across Michigan from Saginaw Bay to Grand Haven (Fig. 1). He states that this species is "Infrequent to locally frequent south of Saginaw Bay in low rich woods; occasional on borders of swamps and in wet open habitats." Hermann did not distinguish the variety *hispidula*, but in a later paper commented, "The form with hispidulous perigynia is evidently more southern and deserving of varietal designation." (Hermann, 1951). Several new southern county records for Michigan have been reported since Hermann's early work (Shiawassee Co., Hermann, 1951; Huron Co., Hebert, 1956; and Oakland Co., Hall and Thompson, 1959). In addition, four county records (Allegan, Branch, Eaton, and St. Joseph) can be added from the Herbarium (MICH). *C. grayii* is now reported from 22 southern Michigan counties. The distribution of the species and the variety is presented in Figure 1.

Curtis in *The Vegetation of Wisconsin* (1959) includes *C. grayii* as a member of the "Southern Wet Forest" confined to the southern part of the state below a line (Tension Zone, Fig. 1) from St. Croix Falls in the northwest to Chippewa Falls, Wisconsin Rapids, Berlin, and Union Grove in the southeast. Tree dominants in the wet forest are listed as *Acer saccharinum*, *Salix nigra*, *Populus deltoides*, *Ulmus americana*, and *Betula nigra*.

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[1] Support for the field work was provided through a Sigma Xi-RESA Research Grant and the Horace H. Rackham School of Graduate Studies, The University of Michigan. Dr. Edward G. Voss, Herbarium, The University of Michigan, verified the identification and kindly commented on the manuscript.

[2] Present address: Research Forester, Ford Forestry Center, L'Anse, Michigan.

I collected *Carex grayii* var. *hispidula* in the western Upper Peninsula of Michigan while conducting studies on the relationships of bryophyte and lichen micro-communities to forest vegetation. This collection (Bevis 145, MICH) was from an upland stand of hemlock *(Tsuga canadensis)*, hard maple *(Acer saccharum)* and yellow birch *(Betula lutea)* in Section 36, T44N, R37W, Iron Co., Michigan. The specimen was growing together with *Carex intumescens* Rudge, a species with which it is easily confused, in a wet depression at the base of a large hemlock. During subsequent sampling in other northern hardwood stands in Iron Co., field observations for the species were recorded from three other localities: a virgin hemlock-white pine *(Pinus strobus)* stand on the shore of Golden Lake (T44N, R37W, Section 36); an old age, upland hemlock-hard maple stand (T44N, R37W, Section 35); and a black cherry *(Prunus serotina)*-yellow birch-hard maple stand (T43N, R37W, Section 27). It is my opinion that *C. grayii* is rare in the western Upper Peninsula of Michigan, but very likely has been overlooked or mistaken for *C. intumescens* by previous collectors. *C. intumescens* is commonly found in second-growth hardwood forests, whereas *C. grayii* is apparently restricted to undisturbed, old age northern hardwood-conifer stands.

This record is of considerable phytogeographic interest as it represents an appreciable northward extension of range of approximately 260 miles in Michigan and 100 miles from the nearest potential locality in Wisconsin. Three other sedges of southern distributional affinities,

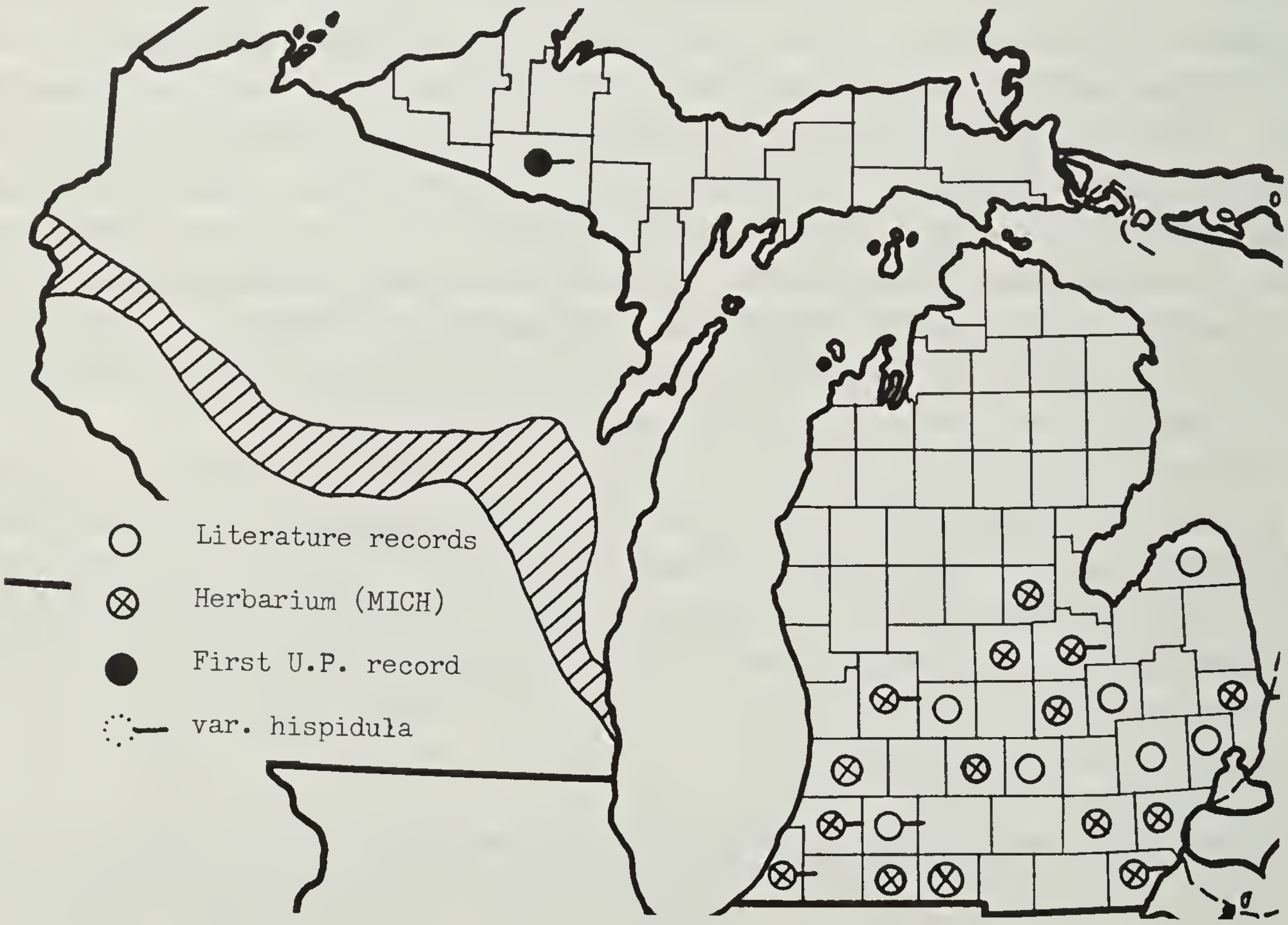

Fig. 1. The distribution of *Carex grayii* and the variety *hispidula* in Michigan. This species most likely does not occur north of the band (Tension Zone of Curtis, 1959) through Wisconsin.

C. hirtifolia Mack., *C. woodii* Dewey, and *C. sprengelii* Dewey, were reported by Hebert (1956) as occurring in Iron Co., Michigan. He comments that these species are "New to northern Michigan; previously not known north of Saginaw Bay." It is interesting to note that Hermann (1951) rejects a report of *C. sprengelii* from the Keweenaw. The presence of these species in western Upper Michigan may represent either the continual northward extension of range to be expected accompanying the gradual amelioration in climate following the last Wisconsin age ice advance, or relict occurrences remaining from a more northern distribution before the increasing disturbance of their habitats by man.

LITERATURE CITED

Hall, M. T., and P. W. Thompson. 1959. An Annotated List of the Plants of Oakland County, Michigan. Cranbrook Inst. Sci. Bull. 39. 93 pp.

Hebert, P. E. 1956. New county records of sedges in Michigan and Indiana. Am. Midl. Nat. 56: 504-506.

Hermann, F. J. 1941. The genus Carex in Michigan. Am. Midl. Nat. 25: 1-72.

———. 1951. Additions to the Genus Carex in Michigan. Am. Midl. Nat. 46: 482-492.

University of Michigan Botanical Gardens

The new site and buildings of the University of Michigan Botanical Gardens were dedicated in ceremonies held at the Gardens on June 14, 1962. Presiding at the dedicatory exercises was University President Harlan Hatcher, who responded to the formal presentation by the Hon. Frederick C. Matthaei, whose generous gifts in 1957 and subsequently made possible the establishment of the Gardens at their present location on Dixboro Road approximately 4 miles northeast of Ann Arbor.

The main speaker at the dedication was William C. Steere, Director of the New York Botanical Garden, whose training at Michigan culminated in his Ph.D. in 1932 and whose teaching continued at his alma mater until he left the chairmanship of the Department of Botany in 1950 to accept a position at Stanford University. Following Dr. Steere's brief and delightful address, the ceremonies were concluded with remarks by A. Geoffrey Norman, who has been director of the Gardens since the retirement of Harley H. Bartlett in 1955.

At the commencement exercises of the University on June 16, the honorary degree Doctor of Science was conferred on Dr. Steere, "Grandson of Michigan's pioneer naturalist Joseph B. Steere . . . respected for the versatility of his talents and interests as well as for his authoritative specialized knowledge, held in affection for his generosity to his peers and younger fellows . ... appropriately serving as director of one of the principal centers for botanical study in the nation and the world."

The present site of the Botanical Gardens includes approximately 200 acres within the fence. The central third, along Fleming Creek, is rich in native vegetation. Greenhouse space totals more than 24,000 square feet (one-third more than at the previous site), with a large display house and some additional classrooms remaining to be constructed when funds permit. All activities were terminated at the Iroquois Drive site in November, 1961.

News of Botanists

Three students at Wayne State University have recently received their master's degree in botany, studying problems in the areas indicated: Jeanette Mullins (*Liatris* in Michigan), Bruce Hayes (a prairie area on Harsen's Island, St. Clair Co.), and James Munson (chromatography in *Viola)*. Jarl Hiltunen completed his studies at Wayne and is now an environmental biologist with the Bureau of Commercial Fisheries, U.S. Fish & Wildlife Service, in Ann Arbor, and is continuing on the side his studies of the flora of Chippewa County and other areas.

Six students at the University of Michigan have recently completed Ph.D. dissertations in botany: Alan Graham ("The Sucker Creek—Trout Creek Miocene Floras of Southeastern Oregon") will be an instructor in botany at the U. of M. this year, offering instruction in palynology for advanced students. Willard Payne ("Biosystematic Studies of Four Widespread Weedy Species of Ragweeds *(Ambrosia:* Compositae)") will continue at the U. of M. as associate research botanist studying ragweeds under a National Institutes of Health project concerned with ragweed hayfever. Martin A. Piehl ("The Natural History and Taxonomy of the Genus Comandra (Santalaceae)") is now taxonomist at the Santa Barbara Botanic Garden, California. James B. Schooley ("The Incompatibility Mechanism of the Biennis Group 1 Races of Oenothera") continues teaching at Highland Park Junior College. Richard A. White ("A Comparative Study of the Tracheary Elements of the Ferns") will be in England for a year on an NSF postdoctoral Fellowship at the University of Manchester. Joan Hubbell Wilce ("Section Complanata of the Genus Lycopodium") returns to the University of Massachusetts where her husband is on the botany faculty. A. E. Schuyler completes his dissertation in September ("A Biosystematic Study of the Scirpus cyperinus Complex"), when he becomes assistant curator, department of botany, Academy of Natural Sciences of Philadelphia (in charge of Department activities). Two additional students move to new jobs where they will continue research: Frederick B. Bevis has become research forester, Ford Forestry Center, Michigan College of Mining and Technology, at L'Anse; and Stanwyn G. Shetler has accepted a position as plant taxonomist (assistant curator of phanerogams), department of botany, Museum of Natural History, Smithsonian Institution.

Dr. George W. Gillett leaves the faculty of Michigan State University for a Fulbright year in Finland, after which he becomes associate professor of botany (taxonomy) at the University of Hawaii. William Malcolm has joined the staff of the biology department at Albion College. Dr. John Beaman will be on sabbatical leave all year, studying Mexican and Guatemalan alpine plants at herbaria in Washington, Cambridge, and Chicago, as well as in Europe (Kew, Paris, Geneva, Berlin, and Copenhagen). Dr. Beaman's replacement at Michigan State for the year will be Dr. Loran C. Anderson, who has recently completed his studies at Rancho Santa Ana Botanic Garden. William T. Gillis spent a week in June studying poison-ivy types in the British Museum, Linnaean herbarium, and Paris. In July and August he joined Keith Longpre for a field trip to Texas and Mexico to college *Sabazia* and *Toxicodendron.* Dr. Henry Imshaug spent a month in the Juneau area of Alaska applying lichenometry to glaciological dating techniques under the auspices of M.S.U., NSF, and the National Geographic Society.

MICHIGAN BIG TREE SURVEY

Paul W. Thompson
Cranbrook Institute of Science

Four years ago the Michigan Botanical Club initiated a survey of the big trees of the State. At that time the 1956 listing of National Champion Trees of different species by the American Forestry Association showed two champion trees located in Michigan. By the beginning of 1961, with the assistance of members, friends, and various conservation organizations, well over one thousand records of large trees had been collected, representing one hundred and twenty different species. Of these, thirty-seven are listed as National Champion Trees,[1] the biggest of their kind in the nation.

As of January, 1961, California, with forty-one champions, held the record for the largest number of champions; Maryland with thirty-eight was second; and Michigan was third. Since this time we have found several more record-size trees so Michigan may now rank as second in the country. With a concerted effort to uncover new records during the coming year, it is quite possible that California can be surpassed and Michigan can become the leader in the nation. Everyone is encouraged to send in new records, especially on the smaller species of trees which are often overlooked because of their smaller size. This includes dogwoods, tamaracks, native spruces, jack pine, choke cherry, pin cherry, box-elder, sumacs, ironwood, blue beech, buttonbush, striped maple, aspens, and witch hazel. Also we have almost surpassed present records for species such as the beech, sugar maple, hemlock, hackberry, sour gum (tupelo) and yellow birch. It is quite possible we have unreported trees of these species large enough to be national champions.

The standard measurement is made of the circumference (in inches) of the trunk at a height of 4-1/2 feet. If the tree is located on an incline, then the midpoint of the slope is used as the base checkpoint. This figure, with the location of the tree, the distance from the nearest town, and the name and address of the observer, should be sent to the Committee secretary, Mrs. Julia Hunter, 4502 Cooper Avenue, Royal Oak, Michigan.

To create interest in big trees and to aid in their preservation the larger specimens of many of the various species have been tagged by the Michigan Botanical Club with 4 x 6 inch aluminum signs which give the common and scientific name of the tree and the designation, "Michigan Big Tree." Over one hundred and fifty trees have been marked to date. In addition to these signs a "National Champion Tree" designation has been added to many of those which hold national records.

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[1] "These Are The Champs," by Dorothy Dixon, Reprinted from American Forests, Jan. and Feb. 1961.

The Northwestern Chapter has created a most interesting tree route; a folder shows the location of Big Trees and gives data on these record-size specimens. It is planned in the future to extend this project to other parts of the State.

In the meantime send in additional data to the Big Tree Committee: Julia Hunter (secretary), Robert Erwin, Fred Haskin, Mabel Kropp, Edward Voss, Paul Thompson (chairman).

ADDITIONAL BIG TREE RECORDS[2]

Tree	Girth, inches	Ht., feet	Spread, feet	Location of tree County: loc.	Nominator
Beech *Fagus grandifolia*	172*		90	Manistee: Portage Lake	H. Harvey & O. Sehanina
Cherry, Black *Prunus serotina*	189	108	91	Berrien: Berrien Springs, A. Glander res.	P.W. Thompson
Chestnut *Castanea dentata*	105			Kalkaska: Hayne Lk.	P. Barrett, et. al.
Dogwood, Gray *Cornus racemosa*	10.5*	19	18	Oakland: Held res., Birmingham	P.W. Thompson
Mountain Ash *Sorbus decora*	40*	42	32	Marquette: Lt. Hse., Big Bay	W.P. Harris, Jr. & P.W. Thompson
Maple, Striped *Acer pensylvanicum*	32*	39	35	Marquette: Huron Mt. Club	W.P. Harris, Jr. & P.W. Thompson
Willow, Brittle *Salix fragilis*	180	55	62	Macomb: 29 Mi. Rd., New Haven	Mabel Kropp
Willow, Brittle	206			Wayne: 8015 Merriman, Livonia	Ray Heilig

*New State Champion

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[2] Since "Big Trees, Supplement IV," August 1961 (Michigan Botanical Club Nature Bulletin).

MICHIGAN PLANTS IN PRINT

It will be our intention to include regularly in this section annotated lists of literature relating to Michigan plant life. It is hoped that these will be of use to schools and libraries as well as to individuals. Two general divisions will be continuing features: "Guide to Literature on the Michigan Flora" and "New Literature Relating to Michigan Botany." Neither can be complete, but both will attempt to cover the items believed to be of most value and interest to our readers. We will appreciate having our attention called to items which should be included. When prices are indicated, they are understood to be the current prices of books in print, but the editors cannot assume responsibility for perfect accuracy. The Michigan Botanical Club does not operate a mail-order book service. Books may be ordered through your local bookstore or from the Michigan Audubon Society Book Shop, c/o Kalamazoo College, Kalamazoo, Michigan.

— E. G. V.

Guide to Literature on the Michigan Flora

2. GUIDES AND MANUALS FOR MICHIGAN VASCULAR PLANTS

In the previous issue we listed general manuals useful in our region but *not* specifically Michigan—oriented. The books and articles below deal with the Michigan representatives of various groups of vascular plants; except as noted, all include keys for identification and distributional data (maps and/or citations of specimens) and intend to be complete for the groups (genus or larger category) covered. In our next issue will be a list of local floras (e.g., county lists) which lack keys and hence are not designed, as are those below, for identification.

Billington, Cecil. 1949. Shrubs of Michigan. 2nd ed. Cranbrook Inst. Sci. (Bull. 20), Bloomfield Hills. 339 pp. [A useful illustrated work by one of the state's most active "amateurs" (until his death). The distribution maps are unfortunately based on numerous unverified literature records as well as on specimens examined, and are not always reliable. $4.50]

Billington, Cecil. 1952. Ferns of Michigan. Cranbrook Inst. Sci. (Bull. 32), Bloomfield Hills. 240 pp. [An illustrated treatment of Michigan Pteridophytes, published posthumously. The distribution maps are based on specimens critically examined by those responsible for completing the work for publication, chiefly Stanley A. Cain and Dale J. Hagenah. For a major group of supplementary records see Am. Fern Jour. 45: 65-80. 1955. $5.00]

Bingham, Marjorie T. 1939. Orchids of Michigan. Cranbrook Inst. Sci. (Bull. 15), Bloomfield Hills. 87 pp. [An account in readable, popular style, with some good photographs and water-color illustrations. However, the key is extremely vague and difficult to use, and there are almost no useful distributional data.]

Case, Frederick W., Jr., and George L. Burrows, IV. 1962. The Genus *Trillium* in Michigan: Some Problems of Distribution and Taxonomy. Papers Mich. Acad. 47: 189-200. [No key, but helpful comments on identification and distribution maps for 8 species, omitting only the ubiquitous *T. grandiflorum.]*

Darlington, H. T. 1921. Distribution of the Orchidaceae in Michigan. Rep. Mich. Acad. 21: 239-261. [The first in a series of papers published by the Michigan Academy of Science, Arts, and Letters, with keys and lists of specimens "examined" and "reported." An old paper, now chiefly of historical interest in indicating the basis of some old records.]

Gleason, Henry Allan. 1939. The Plants of Michigan. 3rd ed. George Wahr, Ann Arbor. 158 pp. [Consists entirely of very workable keys to most of the seed plants of the state, omitting many or all of the species in some of the groups traditionally considered ''difficult,'' such as grasses, sedges, and hawthorns. No distributional data. $2.00]

Hermann, Frederick J. 1941. The Genus Carex in Michigan. Am. Midl. Nat. 25: 1-72. [Keys and over 175 critical distribution maps for this large and difficult group. Additional records in Am. Midl. Nat. 46: 482-492. 1951.]

Kenoyer, L. A. 1924. Distribution of the Umbellales in Michigan. Papers Mich. Acad. 3: 131-165. [Keys and lists of specimens examined and reported for the families Araliaceae, Cornaceae, and Umbelliferae (''Ammiaceae'').]

Kenoyer, L. A. 1924. Distribution of the Ericales in Michigan. Papers Mich. Acad. 3: 166-191. [Similar treatment to the preceding.]

Oosting, Henry J. 1932. Distribution of the Genus Potamogeton in Michigan. Papers Mich. Acad. 15: 141-171. [Similar treatment to the preceding, but with more introductory material on ecology.]

Otis, Charles Herbert. 1931. Michigan Trees. 9th ed., rev. Univ. Mich. Press, Ann Arbor. 362 pp. [A classic, well-illustrated work, with keys, but now somewhat out of date. At most, very general distributional statements for each species. Text ed. $2.25]

Robertson, Betty M. 1941. Distribution of the Ranunculaceae in Michigan. Papers Mich. Acad. 26: 31-59. [Keys and lists of specimens examined and reported.]

Rogers, C. M. 1953. Oxalidaceae in Michigan. Asa Gray Bull. N. S. 2: 267-272. [Very workable key, distribution maps, and exact citations of specimens.]

Rogers, C. M. 1957. Linaceae in Michigan. Asa Gray Bull. N.S. 3:199-204. [Similar format to preceding.]

Smith, Helen V. 1962 [''1961'']. Michigan Wildflowers. Cranbrook Inst. Sci. (Bull. 42), Bloomfield Hills. 465 pp. [A very nicely illustrated guide, with keys, to most of the conspicuous wildflowers of the state, omitting grasses, sedges, rushes, and most aquatics. See review on p. 60 of this issue; a review also in Am. Midl. Nat. (in press). $5.00]

Thompson, Bertha E. 1923. Distribution of the Violaceae of Michigan. Papers Mich. Acad. 1: 167-184. [Similar in format to the other papers published by the Michigan Academy, but in this difficult group perhaps even more out of date than the others.]

Walpole, Branson A. 1927. Distribution of the Cruciferae in Michigan. Papers Mich. Acad. 6: 307-349. [Similar to others in the series.]

Waterman, Ann H. 1960. The Mints (Family Labiatae) of Michigan. Publ. Mus. Mich. State Univ. Biol. Ser. 1: 269-302. [Keys and detailed distribution maps.]

Yuncker, T. G. 1923. The Genus Cuscuta in Michigan. Papers Mich. Acad. 1: 185-189. [Includes key and lists of specimens examined.]

New Literature Relating to Michigan Botany

The aim of this section is to cover all significant literature relating to Michigan botany published since the beginning of 1960, without attempting much coverage of related fields such as agriculture, conservation, and forestry. When the subject matter or relation to Michigan is not clear from the title, annotations are added in brackets.

A. MAPS, SOILS, GEOGRAPHY, GEOLOGY

Topographic maps, published by the U.S. Geological Survey, Washington 25, D.C., are available from the Survey at $.30 each (20% discount on orders for

$10.00 or more). Unless request is made to the contrary, maps are supplied when available with green overprint showing woodland areas (an especially useful feature to botanists). Standard quadrangles represent a unit of 15 minutes each of latitude and longitude (a scale of approximately 1 inch = 1 mile), and are named for a prominent feature in the area. Maps on a larger scale (7-1/2-minute quadrangles) are marked with an asterisk (*) in the list below. An index map of Michigan, showing the location of all quadrangles for which maps have been published, is available without charge. The name of the county in which each quadrangle listed below primarily lies has been added in brackets. The following quadrangle maps have been published thus far in 1961 and 1962. In a later issue we will list all maps of the United States Series (scale of 1: 250,000) which are available for Michigan.

*Allen [Hillsdale]
*Bronson North [Branch]
*Bronson South [Branch]
*California [Branch]
*Camden [Hillsdale]
*Coldwater East [Branch]
*Coldwater West [Branch]
Custer [Mason]
*Fayette [Lenawee, & Ohio]
Glennie [Alcona]
Harrisville [Alcona]
Hart [Oceana]
*Kinderhook [Branch]
*Lyons [Lenawee, & Ohio]
*Morenci [Lenawee, & Ohio]
Washington Island [Delta, & Wisconsin]

LIFE Pictorial Atlas of the World. The Editors of Life and Rand McNally. Time Inc., New York, 1961. 600 pp. [Michigan maps are on pages 146-147 of this weighty new atlas. It is, of course, impossible to include everything on a one-page map, but for one published in 1961 it is surprisingly out of date in regard to interstate highways, none of I-94 being so designated although a few portions of I-75 and I-96 are. The map is generally good for its scale, with a fair number of the smaller communities named. The selection of highways shown seems at times rather arbitrary, some county roads being included but, for example, none of state route M-76 past West Branch, none of M-68 east of Indian River (except where concurrent with M-33), none of M-55 east of West Branch. Only a 6-mile stretch of M-37 is shown, and the U.S. 131 limited access expressway from Grand Rapids southward, while shown as expressway, is in the style for "other roads"—neither "expressway" nor "major roads." To be commended are the correct indications, on both the political map (p. 146) and terrain map, as well as in the text, that the highest point in the state (1980 feet) is in eastern Baraga County. Very mysterious, however, is the large lake (at least as big as Higgins Lake) indicated just east of that high point! Apparently some draftsman filled in blue "water" throughout the entire area between the East and West Branches of the Huron River.]

Reid, John R. [1962]. Sediment Distribution and Landform Classification of the University of Michigan Botanical Gardens. 44 pp. [processed] [A discussion, with maps, of soils and topography; also in press, Papers Mich. Acad. 48.]

B. BOOKS, BULLETINS, SPECIAL REPORTS, AND MISCELLANEOUS

Findell, Virgil E., et al. 1960. Michigan's Forest Resources. Station Paper 82, Lake States Forest Experiment Station, St. Paul, Minn. 46 pp. [Includes a colored map of major forest types and summarizes the Michigan Forest Survey 1946-1957.]

(Michigan Natural Resources Council). 1960. Relationship of Timber and Game in Forest Land Management. 63 pp. [Papers presented at the Annual Meeting, MNRC, including material of conservation interest.]

Morgan, James T., et al. 1961. Outdoor Recreation in the Upper Great Lakes Area. Station Paper 89, Lake States Forest Experiment Station, St. Paul, Minn. 104 pp. [Proceedings of a seminar in research needs, with papers on wildlands, recreation, forest use, and related subjects.]

Smith, Helen V. 1962 [''1961'']. Michigan Wildflowers. Cranbrook Inst. Sci. (Bull. 42), Bloomfield Hills. 465 pp. [See p. 60 & 92 in this issue.]

Smith, Norman F. 1961. Michigan Trees Worth Knowing. 3rd ed. Forestry Division, Michigan Department of Conservation, Lansing. 60 pp. [A well-illustrated treatment, with much useful and interesting information, covering about 55 species. ''Identifying characteristics'' listed for each, but no key and no distributional data. $.50]

Teale, Edwin Way. 1960. Journey Into Summer. Dodd, Mead & Co., New York. [This volume in ''The American Seasons'' is the usual Teale achievement of readable prose combined with infinite detail and endless but exciting fact, and includes, particularly in chapters 6, 7, 12, 13, 14, & 15, an account of travels in both the Upper and Lower Peninsulas of Michigan. Pteridologists who have known the green spleenwort, *Asplenium viride*, in Michigan for the past 30 years will object to the implication (p. 15) that it is found in the U.S. only in New England. Foresters and ecologists who have attempted to reconstruct original vegetational maps from the notes of the original land surveyors, while recognizing that the survey notes are not published books, may still wince to read (p. 143) that ''Hardly a one has left a written record. . .''. And most unexpected of all, expecially from one so obsessed with factual detail as Mr. Teale, is the statement (p. 111) that Michigan's highest point is in the Porcupine Mountains. The error of earlier opinions that an elevation of 2023 feet was attained in the Porcupines was shown by work of the U.S. Geological Survey about 1956, and the correct location of the highest point (Arvon Hills, Baraga Co., 1980 feet) has appeared since 1957 in the *World Almanac*, obtaining its data from the National Geographic Society. But such points as these will hardly detract the reader from a delightful account of the Seney Refuge, Tahquamenon Falls, bears at Copper Harbor, bird's-eye maple near Escanaba, and other glimpses of Michigan natural history. $5.95]

Waterman, Ann H. 1960. The Mints (Family Labiatae) of Michigan. Publ. Mus. Mich. State Univ. Biol. Ser. Vol. 1, No. 8. pp. 269-302. [Includes keys and detailed distribution maps, based on extensive examination of herbarium specimens.]

C. JOURNAL ARTICLES

Baker, H. G. 1961. Heterostyly and homostyly in Lithospermum canescens (Boraginaceae). Rhodora 63: 229-234. [Of interest in Michigan because it resurrects neglected work of one of our most famous botanical sons, Erwin Frink Smith, who long before (1879) had recorded observations in Michigan on style variation in this species.]

Barnes, Burton V. 1961. Hybrid aspens in the Lower Peninsula of Michigan. Rhodora 63: 311-324.

Chopra, Narinder, & A. J. Sharp. 1961. The occurrence of Bryum coronatum in Michigan. Bryologist 64: 64-65. [This moss found at limestone sink in Alpena Co.]

Gillett, George W. 1960. A systematic treatment of the *Phacelia franklinii* group. Rhodora 62: 205-222. [Only Michigan location is Isle Royale.]

Gillett, J. M., & H.A. Senn. 1961. A new species of Agropyron from the Great Lakes. Can. Jour. Bot. 39: 1169-1175. [The Great Lakes plants previously referred to *A. dasystachyum* are deemed a distinct species, *A. psammophilum*. Distribution map and citations of Michigan specimens from which chromosomes were counted (2n = 28).]

Gillis, William T. 1961. Poison-ivy and the poison-oaks. Cranbrook Inst. Sci. News Letter 30: 98-107. [A general discussion, with observation on climbing habit in Michigan.]

PROGRAM NOTES

1962 ANNUAL SPRING CAMPOUT

More than 60 persons attended the annual spring campout of the Michigan Botanical Club, held June 16-17 at the University of Michigan Biological Station, on Douglas Lake. On Saturday was an all-day field trip to Wilderness State Park, led by Ed Voss. In spite of failure of the 20-car caravan to find either a place to buy park entry stickers or a picnic grounds, an excellent assortment of wildflowers were seen, including fringed polygala *(Polygala paucifolia)*, dwarf lake iris *(Iris lacustris)*, one-flowered cancer-root *(Orobanche uniflora)*, ram's-head lady-slipper *(Cypripedium arietinum)*, hairy puccoon *(Lithospermum croceum)*, Indian paintbrush *(Castilleja coccinea)*, butterwort *(Pinguicula vulgaris* — the finest flowering material seen in several years), bird's-eye primrose *(Primula mistassinica)*, dwarf mistletoe *(Arceuthobium pusillum)*, and vegetative plants of the distinctive Lake Huron tansy *(Tanacetum huronense)* and Pitcher's thistle *(Cirsium pitcheri)*.

Arrangements had been made for a hearty family-style dinner at the Methodist Church in Pellston; and in the evening there was a Board of Directors meeting and a brief business meeting at Douglas Lake. At the latter, our new wildflower protection poster, designed by Mrs. S.B. Siddall, was displayed; distribution of the poster to schools and camps is continuing. After the meeting, colored slides of some of the distinctive and interesting plants of the region were shown by Dr. E. U. Clover, who teaches the summer course in systematic botany at the Biological Station.

Sunday morning, those who had rather brave the mosquitoes than the highways enjoyed a bog trip led by Elzada Clover, who took a group to Mud Lake, Reese's Bog, and Bryant's Bog. The showy lady-slipper *(Cypripedium reginae)* was already beginning to bloom—unusually early this season.

Errata

In addition to a few minor typographical errors, the following errata have been noted in Vol. I, No. 1:

p. 17, line 6 of text: For *Ktze.* read Ktze.
p. 19, line 11 of first column of table: For Flow read Flower
p. 25, line 8: For place read places
p. 36, line 4 of 4th paragraph: For Mrs. read Miss
p. 46, line 1: delete repetition of Conservation

NOTICE TO LIBRARIANS, SUBSCRIBERS, & BINDERS

This number completes Volume I of THE MICHIGAN BOTANIST, on the semi-annual schedule announced at the beginning. Starting with Volume II (1963), we will publish quarterly, the size of each issue depending upon the amount of manuscript accepted for publication (and upon the size of our subscription list).

In order to increase our ultimate usefulness to readers, we plan to include an index at the end of each two or three volumes, expecting that those volumes will make a convenient unit to bind together. Note that the cover pages are included in the consecutive pagination and should be bound in.

The date of mailing of the previous number (Vol. I, No. 1) was February 21, 1962.

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(Cover map of the Upper Mississippi, 1843. See page 61.)

JAN 14 1963

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THE
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January, 1963

THE MICHIGAN BOTANIST—Published by the Michigan Botanical Club four times per year: January, March, May, and October. Application to mail at second-class postage rates is pending at Ann Arbor, Michigan.

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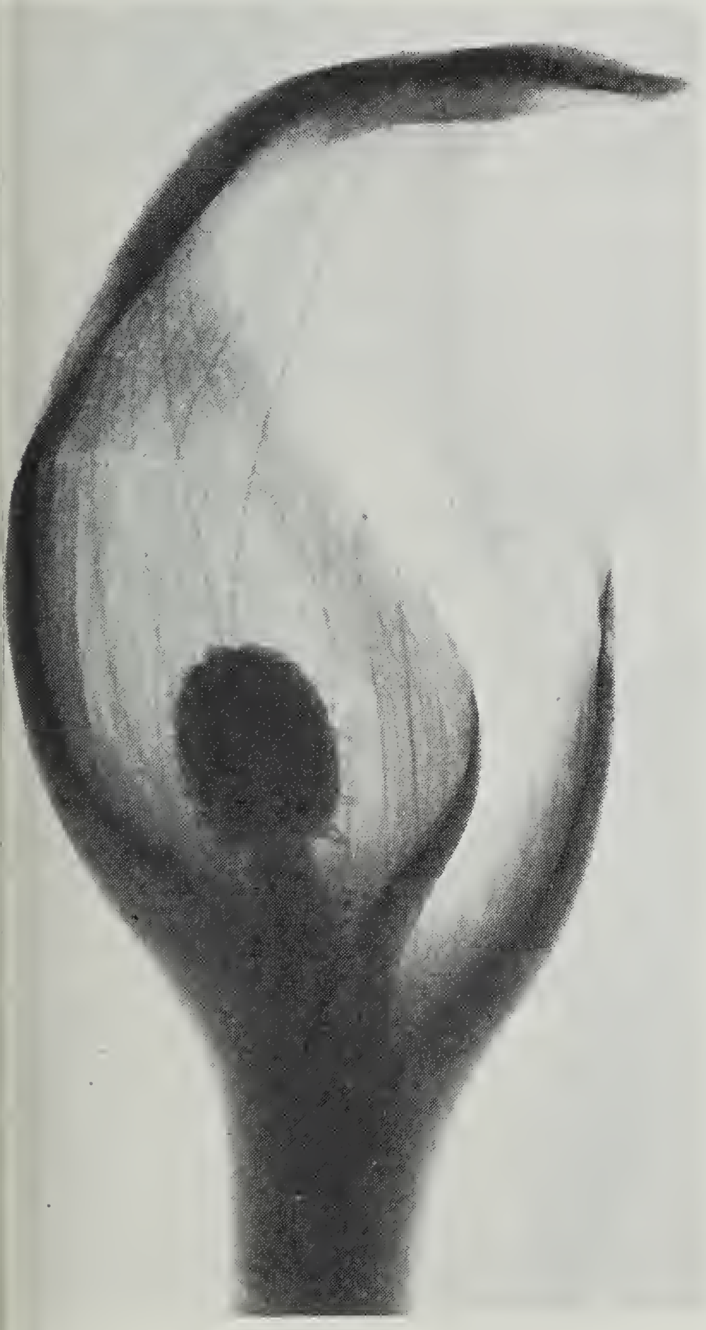
FLORAL RADIOGRAPHY IS MY HOBBY

Albert G. Richards
School of Dentistry, The University of Michigan

Radiographs of flowers have been produced with varying degrees of success ever since Professor Roentgen discovered the X-ray in 1895. Therefore, my hobby is neither new nor original. In pursuing my hobby I have simply refined the techniques that were used by others in the past.

Without going into technical details, the process consists simply of exposing the flower to a suitable source of X-rays and recording the image of the flower on a film.

Although I am not a botanist and can recognize flowers only by their common names, my hobby has made me very aware of the hidden beauty of Nature. Now, as I walk through fields and woods, I see plants in a different light, and find even the lowly weeds are interesting and worthy of admiration.

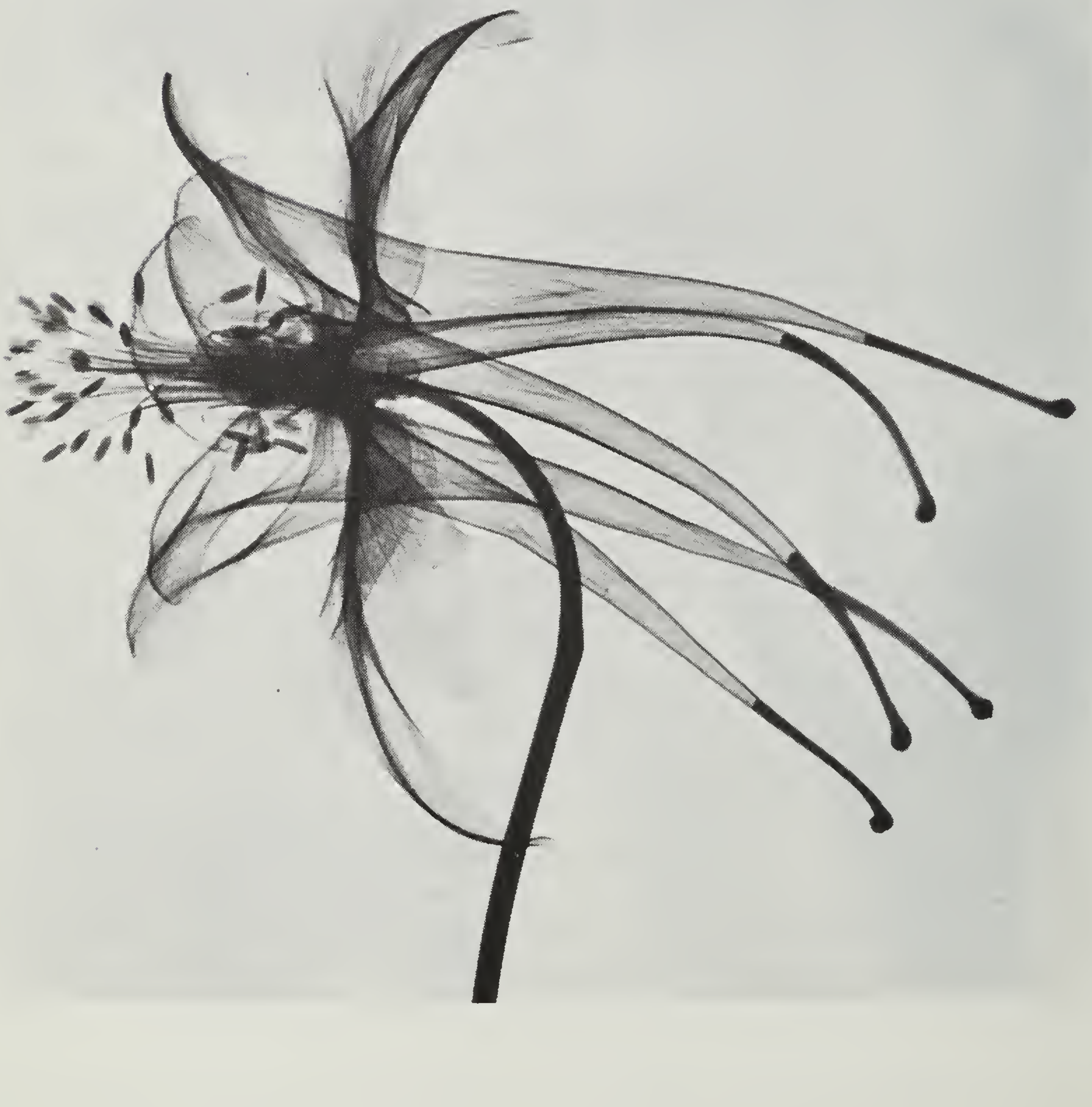


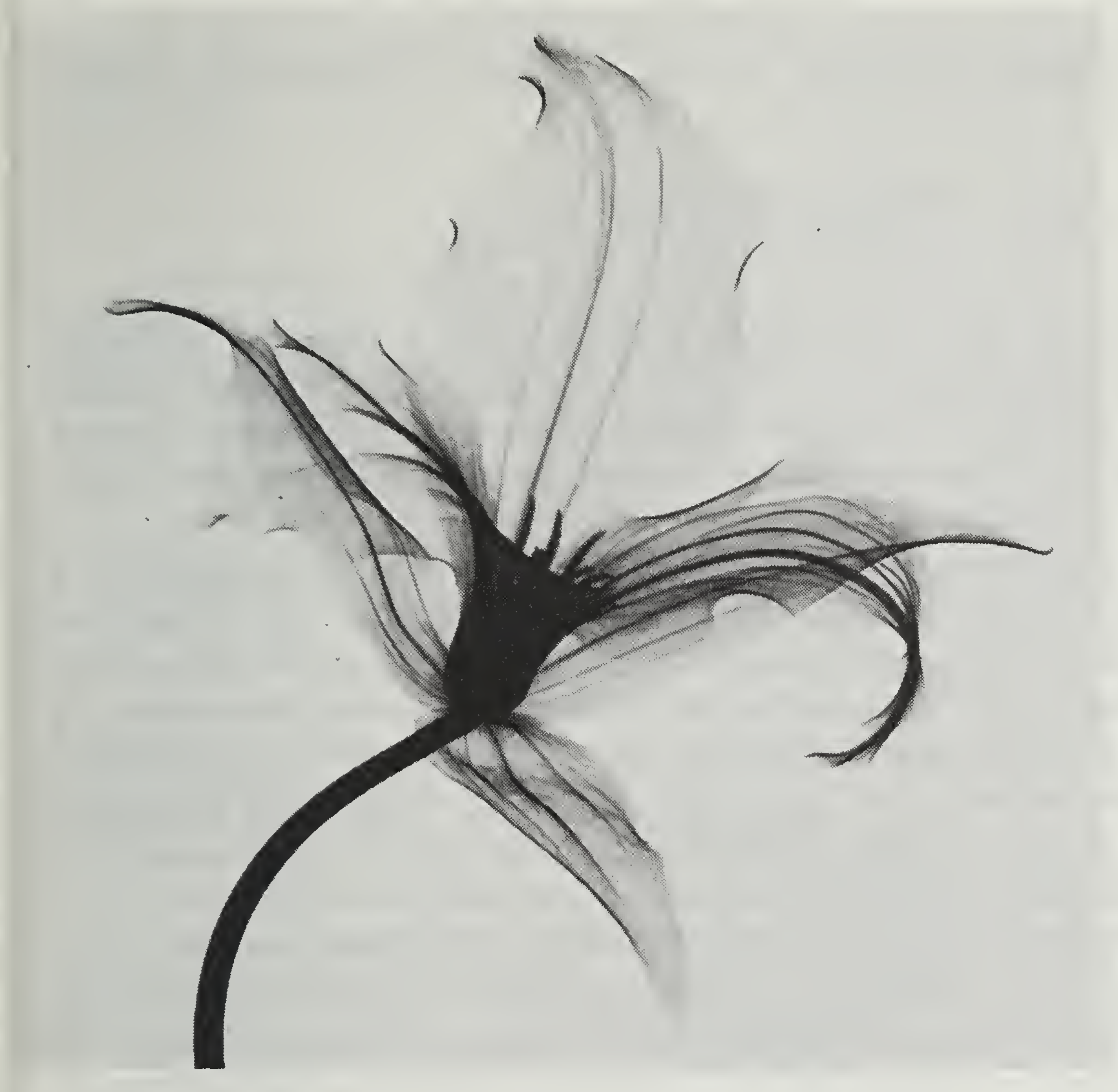
LEFT: Skunk-cabbage (*Symplocarpus foetidus*). One of the earliest blossoms of springtime.

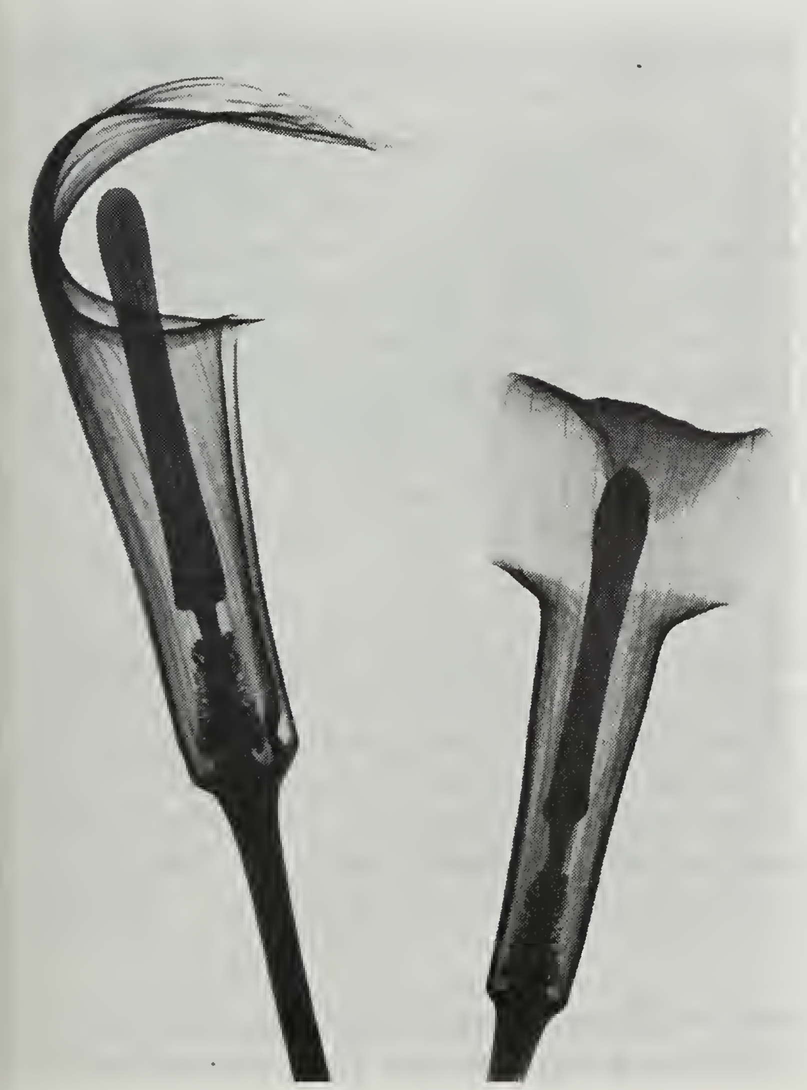
ON THE COVER: Chinese Lantern Plant (*Physalis alkekengi*). A lovely heart-shaped tracery of veins surrounds the spherical berry.

LEFT: Queen Anne's Lace (*Daucus carota*). A roadside beauty.

BELOW: Columbine (*Aquilegia*). The small diameter of the spurs protects the treasure of nectar from the honey bee, but the long tongue of the hummingbird permits it to sample the treasure.







ABOVE: Trillium (*Trillium grandiflorum*). Its beauty lies in its graceful simplicity.

LEFT: Jack-in-the-pulpit (*Arisaema triphyllum*). There is far more to 'Jack' than normally meets the eye.

TRILLIUMS

Some Notes on Opening Phases of an Amateur's Continuing Study

Charles H. Buswell
19204 Plainview, Detroit, Michigan

Until a few years ago I had what I believe is a common general impression about trilliums—that they are a single kind of rather pretty spring-blooming plant with three white petals. At the same time I had forgotten finding a dwarf species as well as the large white ones, many years ago in Iowa.

As my more recent interest in Michigan wildflowers developed, I began to hear about, then to see and photograph, plants and blossoms of differing shapes, colors, and sizes. When I attempted to label my color slides accurately from popular wildflower books, however, I encountered some problems. This only strengthened my interest, which has now developed into an absorbing and continuing personal project to collect and organize additional information to accompany my growing collection of three-dimension (stereo) color slides.

This document records some simple data and observations as a start. I hope it will also be of some interest to others—either in respect to trilliums or in connection with other amateur studies of different plants. It is based primarily on observations and photographs from Michigan, plus a few from Ohio and from the Great Smoky Mountains National Park, including exhibits at Gatlinburg Wildflower Pilgrimages.

For me, many of the features of various species are most readily organized and displayed in tabular form, rather than having only selected features described in separate paragraphs, or set up in series of alternatives as in an identification key. With columns provided for the species, and lines allotted for the several features, a box is provided for recording specific characteristics of each species, allowing instant comparisons. This table will require at least one more spring season of observations for satisfactory completion.

LILY FAMILY (LILIACEAE)

As a starting point, I observe that the genus *Trillium* is found in the large lily family, which has the following general characteristics:

1. They are monocotyledons; leaves are typically simple and entire, with parallel veins.
2. Most are herbaceous, although a few are twining shrubs.
3. Blossoms are generally conspicuous and regular, as well as complete.
4. Sepals and petals—3 of each, usually all colored alike.
5. Stamens—6.
6. Ovary—superior, 3-celled.

Within this lily family are many plants that seem obviously related to each other as lilies. Among these are our Michigan lily, the day lily, and the trout lily, as well as the Trilliums and many cultivated flowers. But the family also contains such differing plants as asparagus, green brier, true and false solomon's seals, the bellworts, wild onion, and many others of varying interest and appearance.

Genus *TRILLIUM*

Once a person has learned to classify one plant as a trillium, it is easy to identify—as trilliums—any others that I have seen or have read about. The wildflower books I use refer to a total of about 25 species of trilliums in temperate North America and eastern Asia. For the northeastern United States and for Michigan they go into detail for only four to ten of this total. The following are readily noticeable general and normal characteristics of trilliums:

a. Found in rich moist woods, appearing early, blooming in April and May, but with leaves and sepals persisting for weeks or a few months.
b. Perennial herbs from short stout rhizomes, also growing slowly from seeds. Species vary from 2 to 24 inches tall, with erect unbranched stems that are usually smooth and often purplish-brown at the base.
c. Leaves—three, ample, simple, and entire; in a whorl at the top of the stem.
d. Blossom—single and relatively large, complete, growing from the center of the whorl of leaves, without bracts.
e. Sepals—three, persistent, basically green.
f. Petals—three, separate, as long as or longer than the sepals, usually a different shape and color from the sepals; apparently never bluish.
g. Stamens—six, separate, identical, stout, and with the anthers attached at their bases, not swinging from their centers as in many larger lilies.
h. Ovary—one, 3- or 6-lobed, forming a berry containing numerous seeds.
i. Stigmas—three, generally divergent and recurved, with little or no single style above the ovary.

The Indian Cucumber Root (*Medeola virginiana*) is ruled out, even though it somewhat resembles the trilliums, by several differences. Among them are its normal two whorls of leaves (with more than three in the lower whorl) and its numerous flowers with similar sepals and petals.

Because trillium leaves may be nearly as wide at the widest point as they are long, and because the minor veins are frequently prominent, the leaves appear net-veined rather than parallel-veined. This might result in doubts as to correct classification as monocotyledons. It can be noted, however, that the principal veins curve back together at the tip of each leaf.

Within the genus *Trillium* there are numerous variations of interest, both normal and abnormal. In checking my pictures and notes I have found that different books, and even different editions of the same publication, vary somewhat in names and in descriptions. This is not without reason. In the first place it is easy to understand older differences of opinion about observed variances in size or shape that may be minor or may be related to local geology, climate, or surroundings. Second, distinct color forms appear that may or may not be considered worthy of distinct names, not to mention problems of describing more subtly varying colors. This is true even with the aid of color films, for their characteristics vary, as do the light conditions and even the processing. Finally, there are occasional freakish variations in the shape, color, or number of parts that appear as a range of possibilities, as variants, or perhaps as hybrids.

In any event, in attempting identifications, it helps to determine, if possible, whether a particular specimen is "normal" to start with. This means checking a number of plants, and plants growing in different places. Leaf-shapes (and their descriptions) seem to me to be too variable to be fully reliable.

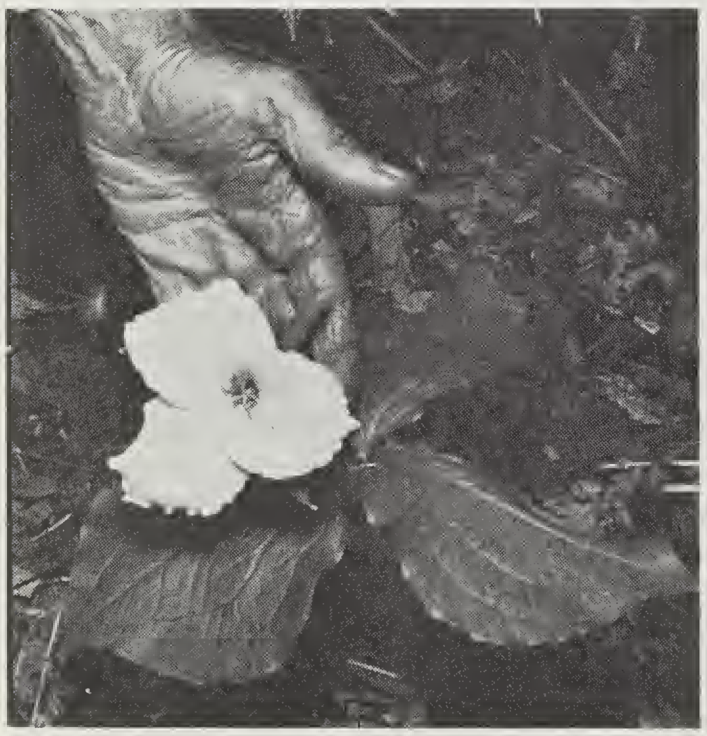
The amateur should "collect" trilliums only by notes and photographs, however, because they are only locally plentiful, if not increasingly rare, particularly in the case of some species, and for that reason are on lists of "protected" plants. Picking of the few leaves deprives the plants of means of providing more material to start the next year's growth. Furthermore, the colors tend to fade, and the specimens become of little use except as organized herbarium records and for expert use. I particularly favor the three-dimension (stereo) slides that show texture, position and lifelike appearance so well, in addition to the shapes and colors recorded by ordinary color slides.

One common name, "Wake Robin," seems to be used so widely but ambiguously for various species that I generally avoid it. Many other published common names are interesting and quaint, but evidently colloquial. Using what appear to be the most wide-spread distinctive common names as well as the scientific names, I cover below some features and variations of interest that seem to merit or require individual comments, apart from any table or key.

TRILLIUM GRANDIFLORUM (Large-flowered white trillium)

This is the most common and widest-ranging of our trilliums, and is often found in large, dense stands. Even so, its appearance at times misleads some people who see pinkish or red petals, which are simply a variable sign of the aging of the spreading (but not flat) originally waxy-white blossoms that may be as large as the palm of your hand, often with overlapping petals.

Sometimes, however, a few or many plants are found bearing petals with definite spots or stripes of green. There may be no white at all, or only a little on the edges or tips of the perianth parts. In some places, South Manitou Island in Lake Michigan, for example, these freaks seem common. Occasionally there are from four to many



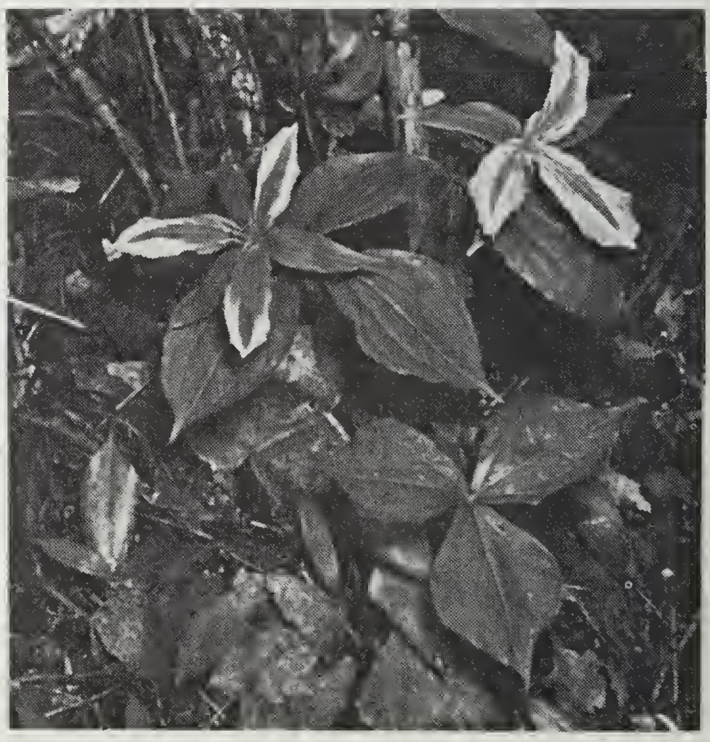


Fig. 1 (left). *Trillium grandiflorum*, Emmet County, Michigan, May, 1960. Normal plant with broad white petals, large blossom, and broad sessile leaves.

Fig. 2 (right). Smaller "sport" blossoms of *Trillium grandiflorum*, with green-centered petals. Leelanau County, Michigan, May, 1954, in an area with numerous, scattered, similar sports.

petals. Blossoms that I have seen with four petals seem otherwise regular, but those with greater numbers are slightly to greatly distorted, possibly involving sepals and stamens as well as petals. I understand that studies are continuing to determine the cause or causes of these variations, their reproduction, and their consistency.

Young plants may appear with only one or two leaves and no flowers, while older ones may occasionally have four or more leaves. Some of these freaks appear in conjunction with flower "sports". In some variations the leaves may have petioles of some length or only short ones, instead of none at all.

There are three things that do seem to be consistent in this species, however: yellow pollen, white pistils, and green sepals. Different colors, and some variations within species, are found in these parts for some other species mentioned below.

Many people have found that these large white trilliums do well in captivity, whereas some other kinds do not grow well in gardens. Plants are available from nurseries, or occasionally from the paths of bulldozers.

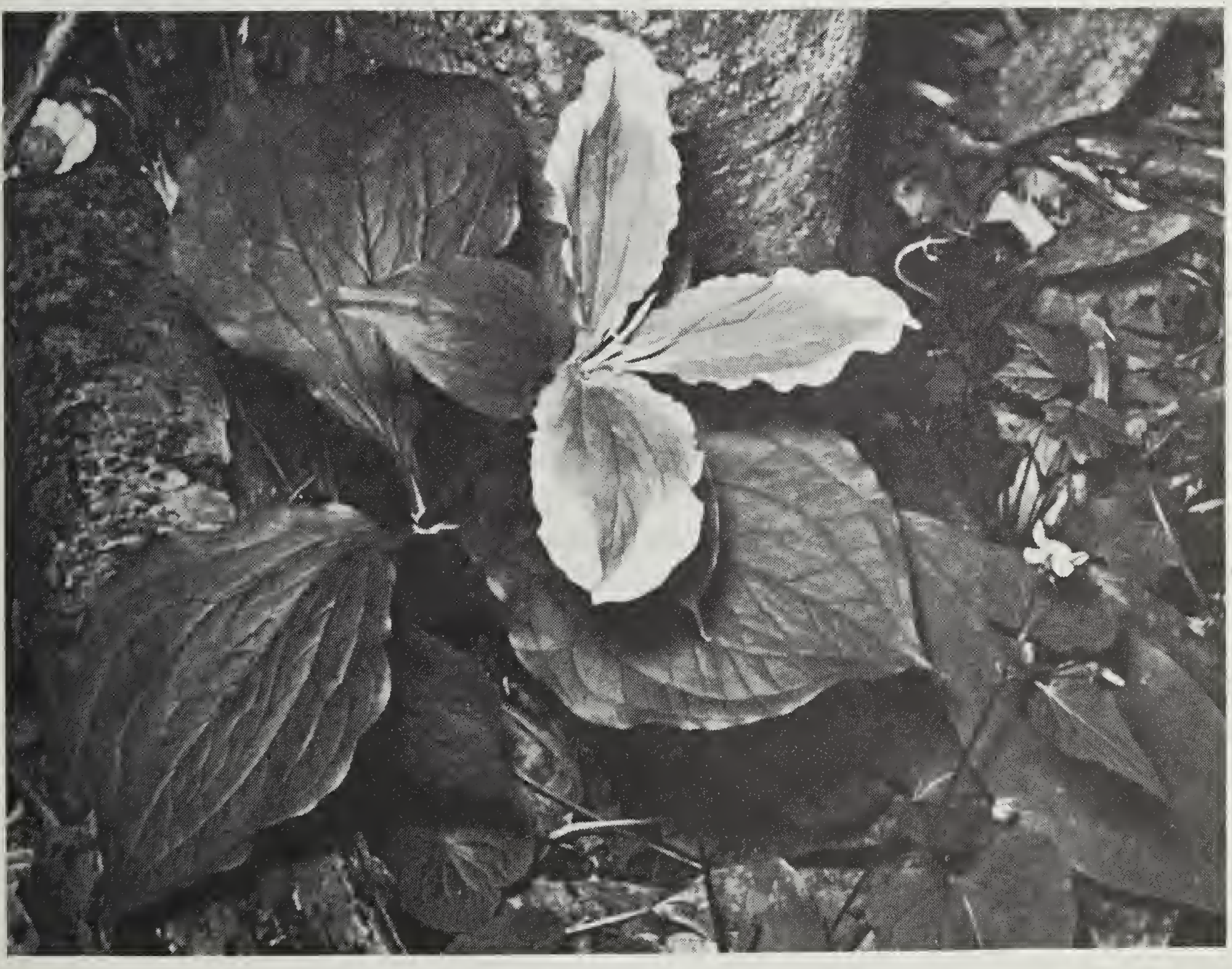


Fig. 3. *Trillium grandiflorum*, large sport with white-bordered light green petals and petiolate leaves. South Manitou Island in Lake Michigan, May 1958, in a colony of varying sports.

TRILLIUM NIVALE (Dwarf or Snow Trillium)

I have not yet found this trillium in Michigan, although it is reported from a few counties, ones where I have visited. Its small white blossom is said to appear as early as March on a plant from two to six inches high. I still have the old pressed specimen from Iowa, however, and may someday find a living plant to compare with it and to photograph.

There are in my home garden, though, some trillium plants of uncertain origin that seem to grow consistently to only about this maximum size. But they do not possess any of the differences (relatively longer petiole, and 3-lobed ovary instead of 6-lobed, for example) that would distinguish them from their *T. grandiflorum* neighbors except their diminutive size! These specimens have now been separated and identified so they can be checked in future years. One plant had four leaves one year, but this did not reappear.

TRILLIUM ERECTUM (Red Trillium)

When I was first introduced to *Trillium erectum,* in the Great Smoky Mountains National Park, I saw what appeared at first to be numerous additional ordinary large white trilliums. But they had consistently wider leaves, spread their petals and sepals in a more nearly vertical plane, and displayed very dark red or nearly black pistils! Then it developed that these were the white form of *T. erectum,* which also appeared (usually in other locations) with dark red petals, and with some other variations. As a matter of fact, I gather from most books that varying reddish colors or brown-purple are normal, although one key implies these are "rarely red"! In Michigan I have seen many reddish ones, but only a few that were pale pink, cream, or nearly white. Other color variations include: pistils varying to light red, pink, or even white, in various combinations with lighter-colored or white petals; various degrees of spreading or reflexing of petals and sepals; and red-tinged sepals.

To date I have seen only one plant with parts in fours. It had white petals but was regular in all other respects. Two plants with two and three three-leaf whorls were only in bud when seen, but I will try to find them again next year. This species of trillium is said to be ill-scented, but this is one aspect that is difficult for me to observe.

TRILLIUM CERNUUM (Nodding Trillium)

This bashful trillium seems to bloom a little later than the others, and is found in many parts of Michigan. The narrower, wavy-edged, and often reflexed petals make a pretty flower, however, that is found underneath the leaves, at the end of a drooping peduncle. Another distinction of this species appears to be possession of stamens that are either equal in length to the pistil or shorter (rather than longer, as in other species) although not all the books agree with me on this point.

Even to my eyes, however, not all trilliums with drooping or hidden blossoms seemed to be of the same species. Some plants are distinctly smaller, and others seem to be consistently larger. Some variations consisted of even narrower and differently-shaped petals or more fleshy ones, as well as showing flowers carried more like the Red trillium. A few plants had varying degrees of red color in various parts or in all parts.

Further reading provided partial explanations that may well be the basis of further investigation and more careful records. Evidently the commoner Michigan plant is the variety *macranthum,* while the somewhat similar *T. flexipes* (also known as *T. gleasoni* or as *T. delinatum*) is described as extremely variable in regard to erectness of peduncles, flower, color, and other characteristics. The Case and Burrows reference listed below presents an interesting proposition concerning possible hybridization.

TRILLIUM UNDULATUM (Painted Trillium)

Speaking once more of the Smokies, it was there, beside some brooks on higher wooded slopes, that I saw scattered plants of the small but colorful Painted Trilliums. The three crimson V's on the white petals form a colorful triangle near the center of a blossom that is backed up by small green recurved sepals. I have yet to see or read of any variants. There are so few reports of this species in limited areas of Michigan that it would be a really unexpected occasion if I ever saw any of these plants here.

* * *

With that species I end the comments on the group of trilliums with peduncled blossoms and rather uniformly green leaves, and turn to mottled leaves and to sessile blossoms that face directly upward, with narrower petals. None of these appear to be very common in Michigan.

TRILLIUM RECURVATUM (Prairie Wake-Robin)

Trillium recurvatum, in my limited experience, is comparatively easy to identify, and seems relatively free from confusing variations. As indicated, the leaves I've seen have all been mottled in two shades of green, and the brownish-purple blossom appears in the center of the leaves without a peduncle. The sepals of mature blossoms are reflexed downward between the short-petioled leaves, and each upright petal is distinctly narrowed for a short distance above its base into what is called a "claw" somewhat like the Wood lily *(L. philadelphicum)*.

TRILLIUM SESSILE (Toad Trillium)

This modest-sized trillium, which takes its botanical name from the lack of peduncles and petioles for flowers and leaves, appears superficially similar to the preceding species, but the sepals are not reflexed, spreading with the leaves, and the petals taper only slightly to their bases.

Most of the flowers I have seen and photographed have been a dull maroon, with this color sometimes spreading to the sepals. The vertical petals are about twice as long as the stamens and tend to touch at their tips. Although one manual says the leaves are not mottled, I seem to have pictorial evidence of some mottling, in agreement with other books.

The same manual says that yellow or green flowers may occur. I have not yet seen these variations growing wild in Michigan, but they must resemble *T. viride,* the green and yellow trilliums of the Appalachians and Ozarks. Leaves, sepals, and petals of these all seem to come from a single point at the top of the stem, as with *T. sessile.* Specimens of *T. viride* in various color combinations are among the many trilliums found in the Beal-Garfield Botanical Gardens at Michigan State University. The yellow form (*T. luteum*) is common in the Smokies, where I also found a few with green-striped petals, and one with only 2 leaves, sepals, and petals. These trilliums are among the largest, more colorful, and most noticeable species I have seen, not considering the large white ones.

* * *

This concludes my formal notes to date (except for the incomplete table of features). Looking through the lifelike and more permanent three-dimension color slides and showing them to others sustains my interest between blossoming seasons. Obviously the subject is open to more observation, reading, and research, in addition to the work being performed by experts. I have the interest and hope to find the time and opportunity. I have already received some assistance and encouragement from educators among the membership of the Michigan Botanical Club.

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Among the references in which I found the preceding notes supported (or in a few cases, contradicted) were these:

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PLANT SUCCESSION IN AN INTERMITTENT POND AFTER TWENTY YEARS

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The University of Michigan

The purpose of this study was to compare the existing vegetation of an intermittent pond with information recorded for that pond twenty years ago.

The pond studied is located on the west side of Carpenter Road about 300 meters north of the crossing of Michigan Ave. (near center of east edge of sec. 24, Pittsfield Township), five and one-half miles southeast of Ann Arbor. Studies were made on this pond (No. II) by Kenk (1949). In his paper, a general vegetation map (Fig. 1a), two photographs, and a list of the occurring plants were presented.

In 1961 visits were made to this pond approximately every two weeks during the period from February 26 to May 27. This pond was dry from the beginning of July to November in 1941. During the 1961 study the pond always contained water and appeared to be starting to dry on the last visit. The vegetation observed by both studies is tabulated in Table I.

This study was done under the direction of Dr. Peter A. Hyypio whose assistance and counsel is acknowledged here.

DISCUSSION OF THE MAJOR ELEMENTS OF THE EXISTING VEGETATION

Alisma subcordatum - The fruits of this species were abundantly collected during the early part of this study, and on May 27 a large number of leaves had reached the surface of the pond. Comparison of the maps and photographs indicates that *Alisma* is less abundant today than during Kenk's study. Apparently this plant has decreased with the advance of *Typha.*

Sagittaria latifolia - Only two small clumps were found during this study.

Ricciocarpus natans - A very large portion of the pond surface was covered by this liverwort on May 6, but by May 27 most of it had disappeared.

Nuphar advena - What appeared to be this plant was found dead from the previous season; however, during the period of study no evidence could be seen of its growth for the present season. Kenk mentioned only two small clumps.

Typha latifolia - This cattail has apparently spread a great deal during the last 20 years but still consists of a single clone at the north and northwest end of the pond.

Cephalanthus occidentalis - This shrub occupies much of the western border of the pond.

Solanum dulcamara - Individuals of this plant were scattered throughout the pond. However, it appeared to be most commonly associated with the *Alisma*.

Lemna minor - Duckweed was not recorded by Kenk and was seldom observed during the early part of this study. When *Ricciocarpus* had reached its peak (May 6), *Lemna* was very scarce. During the succeeding three weeks *Ricciocarpus* steadily declined while *Lemna* increased, and by May 27 *Lemna* was very common and had replaced the liverwort.

Carex sp. - A large stand occurs over much of the southern arm of the pool.

Juncus effusus - Apparently Kenk found only a single very small stand of rush. At present it is well established and borders the southern portion of the main body.

Populus tremuloides - A large mature growth of aspen apparently lacking in 1941 can be found in the northeast corner of the pond.

Iris versicolor - A single stand was recorded in 1941. At present three stands were observed. [Presumably *I. virginica.*]

Eleocharis sp. - A single colony (Fig. 1b) which may be *E. smallii* was found.

Sium suave - By far the most striking feature of the pond today is the luxuriant growth of *Sium*. This is very abundant throughout the pond and is especially dense in the *Alisma* region. It can almost certainly be concluded to be a new arrival since Kenk's study.

The other species are not noteworthy and do not warrant special discussion.

DISCUSSION

Since the original study a large arm has been unundated at the southern end of the pond. This appears to constitute the only major physical change. Despite the near proximity to a major highway the pond was relatively clean and garbage free.

It seems significant to note that for the most part none of the sixteen species listed by Kenk have disappeared from the pond. Nine species appear to have arrived in the past 20 years, the most outstanding being *Sium*. Of these three are woody plants and could not be considered truly aquatic; two are primarily damp shore species, and one, a thallose liverwort. Only three 'truly' aquatic vascular plants, *Sium*, *Lemna*, and *Rumex*, have become significant additions to the pond flora.

The most outstanding changes seem to be in the relative abundance of certain species. It is evident that Typha was the most aggressive plant in the pond and has advanced considerably. *Alisma* has appeared to decrease markedly. It is difficult to draw any conclusions for the other plants but some indications can be derived from the maps.

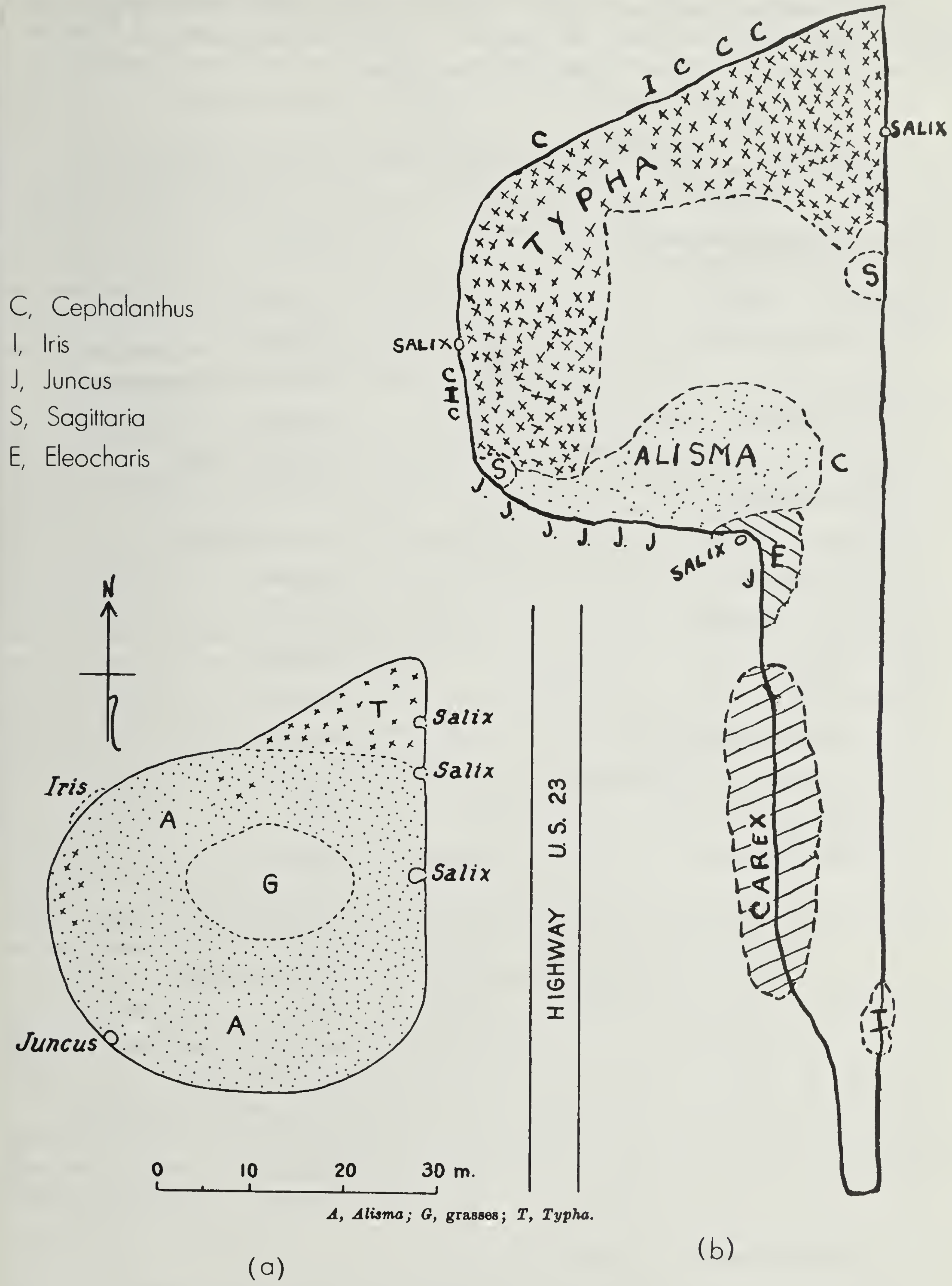
C, Cephalanthus
I, Iris
J, Juncus
S, Sagittaria
E, Eleocharis
TYPHA
ALISMA
CAREX
SALIX
C
I
J
S
E
N
HIGHWAY U.S. 23
T
A
G
Salix
Iris
Juncus
0
10
20
30 m.
A, Alisma; G, grasses; T, Typha.
(a)
(b)

Fig. 1. (a) The pond as observed by Kenk in 1941. (b) The pond as observed by the author in 1961. The scale used by Kenk (a) is also employed in (b). The difference in size probably reflects the measuring techniques of the author rather than a physical change of the body of water. However, relative values for the plant distribution are believed to be correct.

The evidence indicates that this pond has remained a relatively stable entity for the past 20 years. The encroachment of *Populus* and the spread of cattail indicated the usual trend toward extinction.

TABLE I. List of the pond vegetation in 1941 and 1961.

1941	1961
Alisma plantago-aquatica (*= subcordatum)*	present
Sagittaria latifolia	present
Ricciocarpus natans	present
Nuphar advena	appears to be present[1]
Typha latifolia	present
Glyceria septentrionalis	not identified
Carex vulpinoidea	*Carex* sp.
Eleocharis smallii	*Eleocharis* sp.
Juncus effusus	present
Asclepias incarnata	present
Aster sp.	present
Bidens sp.	present
Cephalanthus occidentalis	present
Iris versicolor [*I. virginica?*]	present
Salix sp.	present
Solanum dulcamara	present
	Polygonum sp.
	Lemna minor
	Ricca fluitans
	Rumex orbiculatus
	Barbarea vulgaris
	Sium suave
	Sambucus canadensis
	Vitis sp.
	Populus tremuloides

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[1] See discussion of existing vegetation

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CYTOTAXONOMIC STUDIES IN MICHIGAN ASTERS[1]

Paul Van Faasen
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A majority of the 200-250 species of the large and taxonomically complex genus *Aster* occur in North and Central America. About 33 species are native to Michigan. Chromosome counts have been made in approximately 80 species of which 23 occur in Michigan. This investigation includes 18 species, and has been based on Michigan material because of the need for study of the species in this area and because of the availability of plant material.

As presently defined, the genus *Aster* includes a heterogeneous assemblage of species which traditionally have been grouped into sections, usually on morphological bases. Several segregate genera have been proposed, mostly along section lines. These include *Machaeranthera, Amellastrum, Biotia, Eucephalus, Heleastrum, Ionactis, Oreastrum, Sericocarpus, Doellingeria,* and *Leucelene.* According to Cronquist and Keck (1957) the satellite genera, except for *Machaeranthera,* have no important characters by which they may be recognized, but rather are distinguished by a series of trivial characters which grade into *Aster* proper. In addition to vague generic limits of *Aster,* many species are also problematical. Specific circumscriptions often overlap and species are recognized on the basis of unimportant and inconstant characters. In many cases it is not difficult to recognize most plants of a species, but determinations may be only tentative for specimens near the extremes of variation of a species. The ultimate solution to the taxonomic problems in *Aster* will include many lines of evidence including chromosome numbers. This work was undertaken to provide one of the small pieces which when assembled will present a clear picture of the genus.

Buds, living plants, and voucher specimens were collected in central Michigan in 1960 and 1961. Voucher specimens are filed in the Herbarium of Michigan State University. A complete list of material upon which chromosome counts are based is given in table 1.

Buds were fixed in Carnoy's 6:3:1 (absolute alcohol, chloroform, glacial acetic acid), refrigerated at about 5°C, and kept refrigerated until examined. Squash preparations were made of anthers in iron-acetocarmine.

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TABLE 1. Chromosome numbers of *Aster* species occuring in Michigan

Species	Section	Collection data or reference.[a]	Chromosome number n	Chromosome number 2n	Figure
Aster amethystinus	Aster	Wetmore and Delisle 1939.		10	
A. azureus	Aster	MECOSTA CO.: 5 mi. W. of Morley; 333.	18		1
		NEWAYGO CO.: 6 mi. SE of White Cloud; 352.	18		
		Avers 1953a.[b]	18		
A. ciliolatus	Aster	CHIPPEWA CO.: Sugar Island; Hiltunen in 1962.		72	2
		Avers 1953a	36		
A. cordifolius	Aster	MUSKEGON CO.: 1 mi. S of Bailey; 354.	9		3
		KALAMAZOO CO.: Gull Lake, 2 mi. SW of Hickory Corners; 107, 109.	18		
		CLINTON CO.: St. Johns; 113, 120, 121, 359.	18		4 (120)
		Avers 1953a.	9, 18		
		Avers 1957.	9		
A. divaricatus	Biotia	INGHAM CO.: Botanic Garden, Mich. State Univ.; 271.	9		5
A. ericoides	Aster	JACKSON CO.: 2 mi. S of Waterloo; 279.		10	8
		Delisle 1937.[c]	5		
		Wetmore and Delisle 1939.[c]	5	10	
		Huziwara 1962		32	
A. junciformis	Aster	CLINTON CO.: Rose Lake, 9 mi. NE of Lansing; 216.		32	7
A. laevis	Aster	JACKSON CO.: 5 mi. N of town of Grass Lake; 273.	24		
		BARRY CO.: Kilpatrick Lake, 3 mi E of Woodland; 322.	24		
		CLINTON CO.: 12 mi. NE of Lansing; 330.	24		
		NEWAYGO CO.: 6 mi. E of White Cloud; 339.	24		
		NEWAYGO CO.: 6 mi. SE of White Cloud; 350.	24		6
		IONIA CO.: 5 mi. E of Ionia; 365.	24		
		Revell 1955.		54	
A. lateriflorus	Aster	KALAMAZOO CO.: Gull Lake, 2 mi. SW of Hickory Corners; 108.	8		
		NEWAYGO CO.: 4 mi. E of White Cloud; 344.	8		9
		CLINTON CO. : St. Johns 116.	16		10
		GRATIOT CO.: 7 mi. NE of Ashley; 128.	16		
		BARRY CO.: 3 mi N of Woodland, near Jordan Lake; 325.	24		
		CLINTON CO.: 12 mi. NE of Lansing; 329.	24		11
A. lowrieanus	Aster	Avers 1953a.	18		
A. lowrieanus ?	Aster	MUSKEGON CO.: 1 mi. S of Bailey; 355.	9		12
A. macrophyllus	Biotia	CLINTON CO.: St. Johns; 117, 213.	36		
		INGHAM CO.: East Lansing; 226.	36		
		CLINTON CO.: 14 mi. NE of Lansing; 247, 248.	36		
		CLINTON CO.: 5 mi. E of Bath; 332.	36		
		BARRY CO.: 2 mi. SE of Woodland; 324.	36		
		IONIA CO.: 2 mi. S of Portland; 327.	36		
		MUSKEGON CO.: 1 mi. S of Bailey; 356.	36		14
		Huziwara 1941.		72	
A. modestus	Aster	Huziwara 1958.		18	
A. novae-angliae	Aster	INGHAM CO.: 3 mi. W of Haslett; 133.	5		
		INGHAM CO.: Lansing; 260.	5		
		CLINTON CO.: 7 mi. NE of Lansing; 238.	5		
		CLINTON CO.: 5 mi. E of Bath; 331.	5		
		SHIAWASSEE CO.: 0.5 mi. E of Ovid; 251.	5		13
		Carano 1921.	5		
		Morinaga and Fukushima 1931.	5		
		Delisle 1937.	5		

A. novae-angliae		Wetmore and Delisle 1939.	5		
		Annen 1945.	5		
		Huziwara 1941, 1953, 1958.		10	
		Avers 1954b.	10		
A. patens	Aster	Huziwara 1941.		20	
		Avers 1954b.	10		
A. pilosus	Aster	INGHAM CO.: 3 mi. W of Haslett; 133.	24		
		CLINTON CO.: Park Lake, 7 mi. NE of Lansing; 180.	24		
		CLINTON CO.: St. Johns; 361.	24		
		SHIAWASSEE CO.: 1 mi. SE of Ovid; 182.	24		
		IONIA CO.: 3 mi. W of Ionia; 364.	24		15
		Avers 1954b.	24		
		Huziwara 1958.		48	
A. ptarmicoides	Orthomeris	MECOSTA CO.: 5 mi. W of Morley; 337.	9		
		Huziwara 1941, 1956, 1958.		18	
A. puniceus	Aster	CLINTON CO. : Rose Lake, 3 mi. SE of Bath; 137.	8		
		INGHAM CO.: 4 mi. E of Leslie; 290.	8		17
		GRATIOT CO.: 3 mi. NE of Ashley; 299.	8		
		EATON CO.: 2 mi. E of Eaton Rapids; 307.	8		
		NEWAYGO CO.: 4 mi. E of White Cloud; 341.	8		
		MUSKEGON CO.: 1 mi. S of Bailey; 358.	8		
		IONIA CO.: 3mi. W of Ionia; 362.	8		
		Huziwara 1958.		16	
A. sagittifolius	Aster	GRATIOT CO.: 1 mi. NW of Sumner; 310.	9		
		CLINTON CO.: 12 mi. NE of Lansing; 328.	9		19
		NEWAYGO CO.: 4 mi. E of White Cloud; 345.	9		
		EATON CO.: 2 mi. E of Eaton Rapids; 305.	18		
		MONTCALM CO.: Long Lake, 6 mi. SE of Greenville; 321.	18		
		BARRY CO.: Kilpatrick Lake, 3 mi. E of Woodland; 323.	18		20
		Avers 1953a.	9, 18		
A. sagittifolius var. drummondii	Aster	Avers 1953a.[d]	18		
A. sagittifolius ?	Aster	IONIA CO.: 3 mi W of Ionia; 363.	16		21
A. sericeus	Aster	Annen 1945.		10	
A. shortii	Aster	IONIA CO.: Pewamo; 367.	9		18
		Avers 1953a.	9, 18		
A. simplex	Aster	EATON CO.: 2 mi. E of Eaton Rapids; 306.	16		22
		CLINTON CO.: St Johns; 112, 114.	32		
		CLINTON CO.: 5 mi. N of Bath; 146.	32		
		IONIA CO.: 4 mi. E of Lake Odessa; 326.	32		
		NEWAYGO CO.: 4 mi. E of White Cloud; 343.	32		
		MUSKEGON CO.: 1 mi. S of Bailey; 357.	32		24
		Avers 1954b.	36		
		Huziwara 1958.		64	
A. subulatus	Oxytripolium	Huziwara 1941.	9		
		Wetmore and Delisle 1939.		10	
		Huziwara 1953, 1958.		18	
		Huziwara 1958.[e]		10	
		Turner et al. 1961.	5		
		De Jong and Longpre (unpubl.).	5		
A. umbellatus	Doellingeria	GRATIOT CO.: 3 mi. S of Edgewood; 303.	9		
		SAGINAW CO.: 1.5 mi. W of Marion Spring; 302.	9		
		NEWAYGO CO.: 4 mi. E of White Cloud; 342.	9		23
		INGHAM CO.: Botanic Garden, Mich. State Univ.; 271.	9		
		Huziwara 1962.		18	

[a] Collection numbers are by Van Faasen except where otherwise indicated, and all specimens were obtained in Michigan. Additional counts cited from the literature are not based on material from Michigan. [b] as A. shortii ssp. azureus [c] as A. multiflorus [d] as A. drummondii [e] as A. exilis

A modification of the process of Tjio and Levan (1950) was used for mitotic counts. Root tips were collected in water from plants growing in the greenhouse and transferred to a 0.002 mole/liter aqueous solution of 8-oxyquinoline. They were treated in the 8-oxyquinoline at 15°C for three hours, washed in distilled water, and fixed in Carnoy's 3:1 (95% ethyl alcohol, glacial acetic acid) for 15 minutes. The root tips were then transferred to a solution of 10 parts iron-acetocarmine : 1 part N HCl and heated gently 3 or 4 times for 5-10 seconds per heating with about one minute between heatings. The darkly stained tips were excised in a drop of iron-acetocarmine on a microscope slide and the cells teased apart with dissecting needles. A coverslip was added and pressure applied with the thumb in order to flatten the cells. The chromosomes were observed with a Zeiss WL microscope at an original magnification of 1280 X and drawn with a Zeiss drawing apparatus at 2400 X.

OBSERVATIONS

Aster azureus Lindl. ($n = 18$). This number agrees with Avers' (1953a) count of the taxon which she recognized (1953c) as a subspecies, *A. shortii* ssp. *azureus* (Lindl.) Avers.

Aster ciliolatus Lindl. ($2n = 72$). Avers (1953a) reported the same chromosome number for this species.

Aster cordifolius L. (Heart-leaved or Blue Wood Aster) ($n = 9$, $n = 18$). Both diploid and tetrapolid plants were also found by Avers (1953a). The diploid population (*354*) varied from plants with smooth leaves with winged petioles, characteristic of *A. lowrieanus*, to plants with scabrous leaves and narrow petioles, typical of *A. cordifolius*.

Aster divaricatus L. (White Wood Aster) ($n = 9$). This is the first count for the species and the first diploid number reported in section *Biotia*. It is doubtful whether *A. divaricatus* occurs naturally in Michigan. The material studied was of cultivated origin. All Michigan collections which had been labeled *A. divaricatus* in the major herbaria in Michigan were found to be white-rayed forms of *A. macrophyllus*.

Aster ericoides L. (White or Heath Aster) ($2n = 10$). The chromosome number of this species (as *A. multiflorus* Ait.) was first reported by Delisle (1937). His count and one subsequently reported by Wetmore and Delisle (1939) were $n = 5$. Huziwara (1962) reported $2n = 32$.

Aster junciformis Rydb. ($2n = 32$). This is the first count reported for the species. *A. junciformis* is morphologically similar to *A. adscendens*. Lindl. which has $n = 8$ and $n = 16$ (Clausen, Keck, and Hiesey 1940, p. 386), and to *A. chilensis* Nees with $2n = 64$ (Huziwara 1958). Cronquist (1943) recognized *A. adscendens* as a subspecies of *A. chilensis*.

Aster laevis L. (Smooth Aster) ($n = 24$). A count of $2n = 54$ was reported by Revell (1955). In Michigan this species is morphologically variable, but no irregularities were noted in meiotic figures of the six collections studied.

Aster lateriflorus (L.) Britt. (Calico Aster) (n = 8, n = 16, n = 24). Chromosome counts for *A. lateriflorus* have not been previously reported, and this is also the first time that three ploidy levels have been found in one species of *Aster*. Collections *108* and *344* have n = 8 and the plants are morphologically typical for *A. lateriflorus*. Collection *116* and *128* have n = 16 and the lower surface of the leaf is slightly more pubescent than in typical material. Short stolons are also present on some of these specimens. Collections *325* and *329* with n = 24 are plants with extensive stolons and still more pubescence on the undersurface of the leaf. The pubescence on the undersurface of the leaf and the presence of stolons are characters of *A. ontarionis* Wieg.

After the three chromosome numbers were detected and the correlation between the presence of stolons and polyploidy noted, the pollen quality was checked. This was determined by crushing unopened florets in iron-acetocarmine, counting 200 pollen grains, and considering those which did not stain darkly to be aborted. A high percentage of aborted pollen grains might suggest that the plants were not reproducing by sexual methods.

Nearly every one of the 78 herbarium specimens of *A. lateriflorus* examined contained some aborted pollen grains and 29 specimens had more than 10 per cent aborted grains. There was little or no correlation, however, between the presence of stolons and aborted pollen. One plant (*329*) with n = 24 and with extensive stolons had 88 per cent aborted grains, while another (*325*) had two per cent aborted grains. Of the plants with n = 8, one (*118*) had three per cent and another (*108*) 44 per cent aborted grains. Other herbarium specimens contained from 2 to 70 per cent aborted pollen.

Aster lowrieanus ? Porter (n = 9). Collection *355* fits the description of *A. lowrieanus* as given by Fernald (1950), but plants with smooth leaves and winged petioles are one extreme of a highly variable population with typical *A. cordifolius* at the other extreme, both with n = 9. Possibly the part of the population fitting the description of *A. lowrieanus* might better be considered variant forms of *A. cordifolius*.

Aster macrophyllus L. (Large-leaved Aster) (n = 36). All collections studied had n = 36 and meiosis was regular. The species is morphologically variable, and populations have been observed which included as many as three forms which have been described at the varietal level.

Aster novae-angliae L. (New England Aster) (n = 5). Some pollen mother cells of collection *251* contained one or two chromosome fragments in addition to the normal chromosome complement. This population included plants with rays varying from rose-violet to deep blue-violet. In one metaphase configuration (fig. 13), it appeared that a fragment was dividing and acting as a sixth chromosome. Avers (1954b) reported a tetraploid population of *A. novae-angliae*. None was encountered in this study and several other investigators (see table 1) also have found only diploid plants.

Aster pilosus Willd. ($n = 24$). No meiotic irregularities were found although the species is morphologically variable.

Aster ptarmicoides (Nees) T. & G. ($n = 9$). One collection was studied and no meiotic irregularities were noted.

Aster puniceus L. (Red- or Purple-stemmed Aster) ($n = 8$). Specimens which could be determined as *A. lucidulus* (Gray) Wieg. are included under this species. Most pollen mother cells in collection *290* contained one to three chromosome fragments (fig. 17), but no irregularities were found in other collections.

Aster sagittifolius Wedem. ex Willd. (Arrow-leaved Aster) ($n = 9$, $n = 18$). Both diploid and tetraploid populations were also found by Avers (1953a). Although the species is morphologically variable, no correlation was noted between the chromosome number and the mode of variation.

Aster sagittifolius ? ($n = 16$). This collection, *363,* with the anomalous chromosome number has both white- and blue-rayed plants, and the inflorescence is a little looser than in typical *A. sagittifolius*. The buds, however, are nearly cylindrical as are buds of *A. sagittifolius*. Morphologically the plants resemble *A. sagittifolius* more closely than any other species. A hybrid origin for this population might be possible, but is difficult to explain since all species related to *A. sagittifolius* have a basic number of $x = 9$. The only other species of *Aster* found nearby were *A. pilosus* which grew among these plants, and *A. puniceus* which was found about 100 yards away. A hybrid of the latter two species, both sessile-leaved, would hardly be expected to have long, winged petioles as does this population, and a hybrid of either of them with *A. sagittifolius* or a species related to *A. sagittifolius* would not likely produce a population with $n = 16$.

Aster shortii Lindl. ($n = 9$). Avers (1953a) found $n = 9$ in one plant from Iowa, but all other material of this species she examined was tetraploid.

Aster simplex Willd. (Panicled White Aster) ($n = 16, n = 32$). All material studied has $n = 32$ except collection *306* with $n = 16$. Previously published counts for this species differ. Avers (1954b) found $n = 36$, while Huziwara (1958) reported $2n = 64$.

Aster umbellatus Mill. ($n = 9$). This count agrees with one by Huziwara (1962) for the species.

DISCUSSION

Three basic chromosome numbers, $x = 5$, $x = 8$, and $x = 9$ occur in *Aster*. A controversy concerning the ancestral basic number of the genus has recently appeared in the literature. Huziwara (1958, 1959) and Raven *et al.* (1960) state that since the majority of the species studied have $x = 9$, this is an indication that the ancestral basic number of the genus is $x = 9$. They consider species based on $x = 5$ and $x = 8$ to be derived through aneuploid loss from ancestral stock with $x = 9$. Turner *et al.* (1961) argue that since there are no species of *Aster* with $x = 6$ and $x = 7$, it is more likely that the ancestral basic number was $x = 5$ and/or $x = 4$, and that the numbers $x = 8$ and $x = 9$ are of allopolypolid origin. They believe that the numbers $x = 6$ and $x = 7$ never existed rather than having been selected against and eliminated as suggested by Raven *et al.*

Only the basic number $x = 9$ is now known in sections *Alpigenia, Biotia, Doellingeria, Orthomeris, Pseudocalimeris, Teretrachenium,* and *Tripolium*. Two sections, *Aster* ($x = 5$, $x = 8$, and $x = 9$ and *Oxytripolium* ($x = 5$) have other basic numbers.[2] All *Aster* species with basic numbers other than $x = 9$ are North American.

Some patterns are evident in the distribution of the commoner species of section *Aster* in Michigan according to their basic chromosome numbers. Species with $x = 9$ are found primarily in the southern two-thirds of the Lower Peninsula with a few collections to the north of this area. One species (*A. ciliolatus*, $n = 36$) is restricted to the Upper Peninsula and the extreme northern tip of the Lower Peninsula. With one exception, species having $x = 5$ are found south of a line running approximately from Bay City to Frankfort in the Lower Peninsula. The few collections of *A. ericoides* ($n = 5$) from Menominee County in the Upper Peninsula are likely extensions of the species from Wisconsin. *A. sericeus* ($n = 5$) is restricted to the relict prairie areas in the southwestern part of the Lower Peninsula. All species with the basic number $x = 8$ are widely distributed throughout the State. Three species of other sections, *A. macrophyllus* (*Biotia*), *A. ptarmicoides* (*Orthomeris*), and *A. umbellatus* (*Doellingeria*) are widespread throughout the State.

Chromosome counts differ for *A. subulatus* (section *Oxytripolium*) and *A. exilis*, which has been referred to *A. subulatus* by Shinners (1953). Huziwara (1941, 1953, 1958) reported $n = 9$ for *A. subulatus* and $n = 5$ for *A. exilis* (1958), while Wetmore and Delisle (1939), Turner *et al.* (1961), and De Jong and Longpre (unpubl.) found $n = 5$ for *A. subulatus*. The problem here appears to be taxonomic rather than cytological.

On the basis of morphology, species of section *Aster* with the basic number $x = 5$ do not appear to be closely related. However, *A. novae-angliae* and *A. ericoides* hybridize freely in the laboratory and frequently in nature forming *A.* × *amethystinus* Nutt. Other species apparently not closely related, but with the basic number $x = 5$, include *A. turbinellus* ($n = 50$, Avers 1957), *A. sericeus* ($n = 5$) and *A. patens* ($n = 10$).

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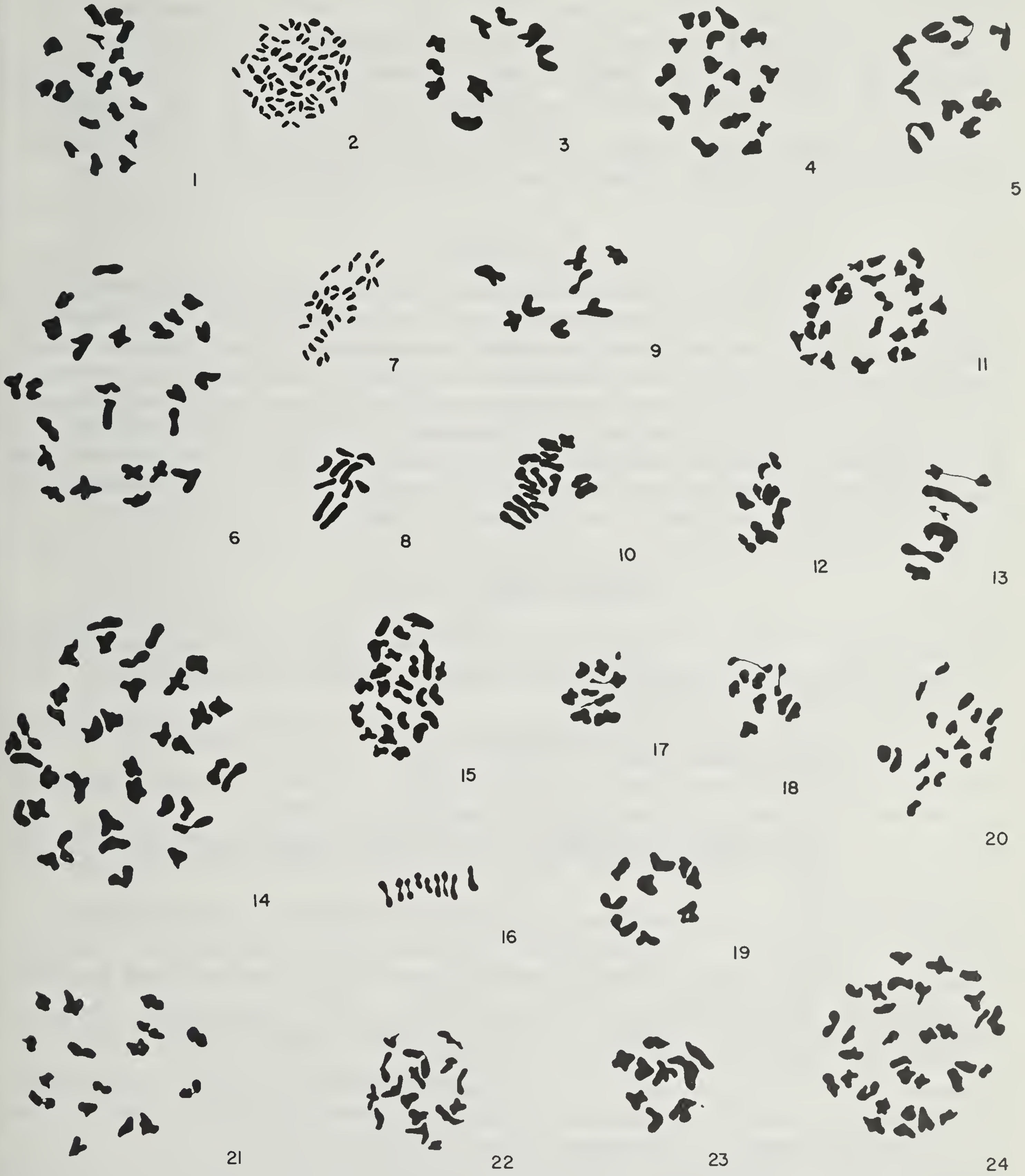
[2] Correspondence with Drs. Raven and Solbrig indicate the probability of error in indicating *Leucelene* as a section of *Aster* by Raven *et al.* (1960). Apparently *Leucelene* has not been made a section of *Aster*, and no other reference to it as a section of *Aster* has been found in the literature. It seems best to recognize *Leucelene* as a distinct genus with one species, *L. ericoides* (cf. Shinners 1946). The count of $n = 16$ for *Aster hirtifolius* (Raven *et al.*, 1960) should be referred to *Leucelene ericoides*.

Most of the taxonomic difficulties in section *Aster* in Michigan are found in species with the basic number $x = 8$. Among these are *A. laevis* and *A. puniceus*, both of which have been subdivided by some authors. Rydberg (1931) split *A. laeviformis* from *A. laevis* and stated that the new species belonged to the *A. puniceus* group. *A. laeviformis* has subsequently been submerged in *A. laevis* by Shinners (1941). The count for *A. laevis* in this study shows that *A. laevis* and *A. puniceus* have the same basic number, $x = 8$. Morphologically these two species are more similar to each other than are other groups of species which apparently are related. *A. lucidulus* (Gray) Wieg. was segregated from *A. puniceus* and is recognized by a number of authors. *A. simplex* ($x = 8$) as presently recognized includes a number of forms which at one time were considered separate species and varieties. Most individuals of *A. simplex* are not difficult to recognize, but extreme variants of the species are difficult to determine. Wiegand (1928) has discussed problems in this species complex.

Another taxonomic difficulty concerns *A. lateriflorus* ($x = 8$), which has a diversity of forms. The disk corolla seems to be the most dependable character for identification of *A. lateriflorus*. The corolla lobes are 50 to 75 per cent of the total length of the limb and may be easily observed in the field with a hand lens. Attempts to identify this species by other gross morphological characters are often frustrating. As suggested in the observations of *A. lateriflorus*, polyploidy may contribute to the taxonomic difficulties in the species. *A. pilosus* ($x = 8$) may often be confused with *A. simplex* and *A. lateriflorus*. Most specimens of *A. pilosus* are not difficult to recognize, but some varieties and forms approaching the extremes of variation are very difficult to determine. Hybridization among *A. simplex*, *A. pilosus*, and *A. lateriflorus* and other species undoubtedly contributes to the confusion.

While hybridization and polyploidy complicate the understanding of *Aster* in Michigan, the most important factor, however, appears to involve the sensitivity of the species to fluctuations of environmental factors. Differences in type of soil, soil moisture, amount of shade, and direction of exposure may all affect the morphology of the plants. (In *A. junciformis*, for example, individuals growing on sandy lake shores vary considerably from those growing in bogs, the usual habitat of the species.) Some confusion in species with $x = 8$ results from the enormous numbers of these plants in Michigan. Although the per cent of plants at the extremes of variation of the species may not be greater than in other groups, numerically there are more individuals at the extremes and an exaggerated idea of the difficulty



Figures 1-24. Camera-lucida drawings of chromosomes of Michigan *Aster* species, all ca. × 675.

Fig. 1. *A. azureus*, $n = 18$. Fig. 2. *A. ciliolatus*, $2n = 72$. Fig. 3. *A. cordifolius*, $n = 9$. Fig. 4. *A. cordifolius*, $n = 18$. Fig. 5. *A. divaricatus*, $n = 9$. Fig. 6. *A. laevis*, $n = 24$. Fig. 7. *A. junciformis*, $2n = 32$. Fig. 8. *A. ericoides*, $2n = 10$. Fig. 9. *A. lateriflorus*, $n = 8$. Fig. 10. *A. lateriflorus*, $n = 16$. Fig. 11. *A. lateriflorus*, $n = 24$. Fig. 12. *A. lowrieanus?*, $n = 9$. Fig. 13. *A. novae-angliae*, $n = 5$. Fig. 14. *A. macrophyllus*, $n = 36$. Fig. 15. *A. pilosus*, $n = 24$. Fig. 16. *A. ptarmicoides*, $n = 9$. Fig. 17. *A. puniceus*, $n = 8$. Fig. 18. *A. shortii*, $n = 9$. Fig. 19. *A. sagittifolius*, $n = 9$. Fig. 20. *A. sagittifolius*, $n = 18$. Fig. 21. *A sagittifolius?*, $n = 16$. Fig. 22. *A simplex*, $n = 16$. Fig. 23. *A. umbellatus*, $n = 9$. Fig. 24. *A. simplex*, $n = 32$.

of the group may result. Disturbance of the original presettlement vegetation probably has reduced the rigor of former selective pressures and permitted formerly less-fit combinations to survive. Mechanical or insect injury may cause bizarre forms of some species. Clarification of all taxonomic problems in the genus is not imminent, but employment of the many new techniques available to the taxonomist should eventually resolve many of the difficulties.

SUMMARY

Chromosome numbers were determined in18 of the approximately 33 species of *Aster* which occur in Michigan. Counts in three species (*A. divaricatus*, *A. junciformis*, and *A. lateriflorus*) are reported for the first time. Numbers differing from previous counts were found in *A. ericoides*, *A. laevis*, *A. lowrieanus* ?, *A. sagittifolius* ?, and *A. simplex*. Four species were found with more than one ploidy level; diploid and tetraploid populations occurred in *A. cordifolius* and *A. sagittifolius*, diploids, tetraploids, and hexaploids in *A. lateriflorus*, and tetraploids and octaploids in *A. simplex*. Taxonomic problems apparently result from hybridization, polyploidy, and phenotypic plasticity.

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Turner, B. L., W. L. Ellison, and R. M. King. 1961. Chromosome numbers in the Compositae, IV. North American species, with phyletic interpretations. Am. Jour. Bot. 48: 216-223.

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OUR NATIVE PLANT PROTECTION POSTER

Elizabeth Siddall
3575 Teggerdine Rd., Clarkston, Michigan

At their first meeting in 1960, the Board of Directors of the Michigan Botanical Club accepted the following resolution: "Be it resolved that the Michigan Botanical Club favors in addition to present laws concerning the preservation of native plants, a basically sound educational policy of conservation designed to more completely protect our native plant resources."

Early in 1962 a committee composed of Mrs. Helen Smith, Mr. Charles Buswell, and Mrs. Elizabeth Siddall as chairman was appointed to carry out the objectives of this resolution. At the next Board meeting, a poster created by the committee chairman was submitted for board approval. With minor changes, the poster was accepted. The Jack-in-the-Pulpit, the emblem of the Michigan Botanical Club, was used as the spokesman for all native plants. The first 1,000 copies were printed as an anonymous donation and ready for distribution in May. (See page 28.)

The poster was endorsed early by prominent individuals throughout the state. In a letter to the committee chairman, Governor John B. Swainson said: "The poster was cleverly devised and I extend my congratulations to you for the creation of 'Jack.' This is an important program especially to us in Michigan and I have every confidence that your concentrated program will be of great benefit."

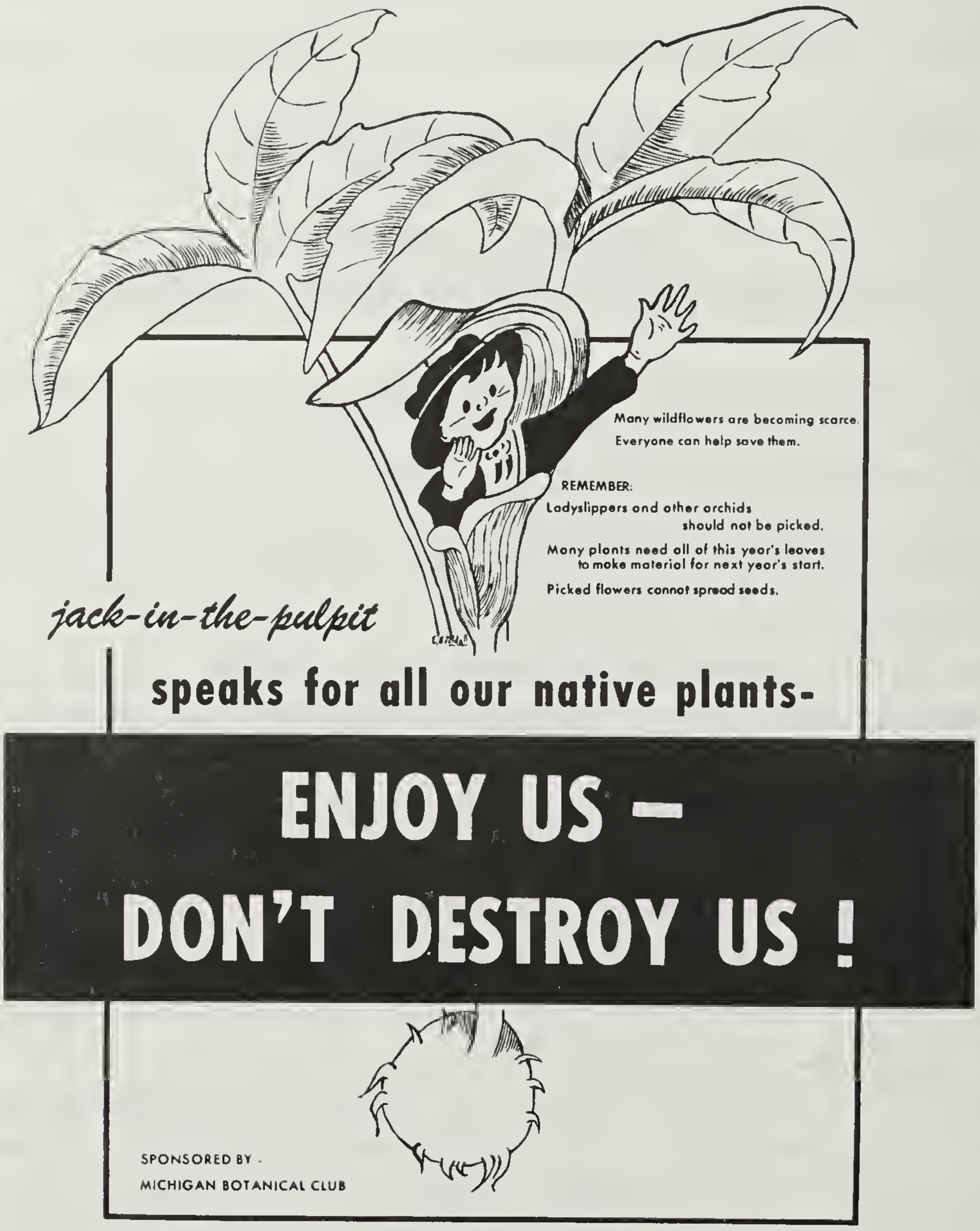
Arthur E. Elmer, Chief of the Parks and Recreation Division of the State Department of Conservation, wrote: "We have mailed these posters to our Regional Offices for distribution for all the parks."

Dr. B. E. S. Hamilton of the State Department of Public Instruction wrote: "I wish you all success possible in your poster project and we are looking forward to receiving copies so that we may reproduce them."

Dr. William Emerson, County School Commissioner of Oakland County, has stated that it is a much needed and appropriate subject to be distributed throughout the schools. The board of education of the Detroit Public Schools has approved placement of copies in every science and elementary classroom in the Detroit Public Schools.

Dr. Alfred Etter, associate professor in the Department of Fisheries and Wildlife, Michigan State University, wrote: "I will be glad to distribute copies of your poster to my classes at the university."

Requests for the poster may be directed to the author or to Mr. Tom Varley, 14110 Sorrento, Detroit 27, Michigan.



Many wildflowers are becoming scarce.
Everyone can help save them.

REMEMBER:
Ladyslippers and other orchids should not be picked.
Many plants need all of this year's leaves to make material for next year's start.
Picked flowers cannot spread seeds.

jack-in-the-pulpit
speaks for all our native plants-

ENJOY US –
DON'T DESTROY US !

SPONSORED BY
MICHIGAN BOTANICAL CLUB

MICHIGAN PLANTS IN PRINT

[We are holding until the March issue the listing of Michigan local floras (county lists, etc.), which will constitute part 3 of "Guide to Literature on the Michigan Flora." The limited space available in the present issue is used to reduce the backlog of new literature references.

E.G.V.]

New Literature Relating to Michigan Botany

The aim of this section is to cover all significant literature relating to Michigan botany published since the beginning of 1960, without attempting much coverage of related fields such as agriculture, conservation, and forestry. When the subject matter or relation to Michigan is not clear from the title, annotations are added in brackets.

A. MAPS, SOILS, GEOGRAPHY, GEOLOGY

County Maps. District 5 of Region II. [The new map books for the Upper Peninsula and southern Lower Peninsula were reviewed in Vol. 1, p. 46. Individual maps, maintaining the same high standards, are now available for 8 of the counties in the northern Lower Peninsula (Alpena, Antrim, Charlevoix, Cheboygan, Emmet, Montmorency, Otsego, Presque Isle), although the book for the entire region is not expected until 1964. A single map is free; additional ones are $ .10 each, plus 4% Michigan Sales Tax; order from Michigan Department of Conservation, Maps & Publications, Lansing 26. The Cheboygan Co. map includes Bois Blanc Island, which, as it notes, is part of Mackinac Co. It and the Otsego Co. map show the interchanges on Interstate Highway 75, a helpful feature to those accustomed to use back roads. It is a personal disappointment to your editor to see the Conservation Department continue to mislocate McGulpin Point in Emmet County (it should be the point designated "Long Point" on the map).]

C. JOURNAL ARTICLES

Beaufait, W. R., & R. T. Brown. 1962. Phytogeography of a representative outwash plain jack pine site. Papers Mich. Acad. 47: 201-209. [A study in Baraga Co.]

Benninghoff, William S. 1960. Pollen spectra from bryophytic polsters, Inverness Mud Lake bog, Cheboygan County, Michigan. Papers Mich. Acad. 45: 41-60.

Benninghoff, William S., & A. I. Gebben. 1960. Phytosociological studies of some beech-maple stands in Michigan's Lower Peninsula. Papers Mich. Acad. 45: 83-91. [Data from stands in Wayne, Oakland, Washtenaw, Cheboygan, Emmet, and Mackinac (Bois Blanc Isl.) counties.]

Benninghoff, William S., & Claude W. Hibbard. 1961. Fossil pollen associated with a late-glacial woodland musk ox in Michigan. Papers Mich. Acad. 46: 155-159. [Data from Kalamazoo Co.]

Bevis, Frederick B. 1960. Phytosociological study of Inverness Mud Lake bog, Cheboygan County, Michigan. Papers Mich. Acad. 45: 61-75. [A quantitative study 35 years after early work by Goe, et al. (consistently cited as "Coe").]

Bourdo, Eric A. 1961. Some observations on a virgin stand of eastern white pine. Papers Mich. Acad. 46:259-265. [Data on a tract in Baraga Co.]

Brown, Robert T., & William R. Beaufait. 1961. Phytogeographical relations of a Pinus banksiana forest [Abstract]. Bull. Ecol. Soc. Am. 42:110. [Abstract of report on work in Baraga Co.; see also under Beaufait above.]

Case, Frederick W., Jr., & George L. Burrows, IV. 1962. The genus *Trillium* in Michigan: Some problems of distribution and taxonomy. Papers Mich. Acad. 47: 189-200. [See Mich. Bot. 1: 91. 1962.]

Dick, M. W. 1961. *Brevilegniella keratinophila* gen. nov., sp. nov. Papers Mich. Acad. 46: 195-204. ["The fungus described in this paper was isolated on human hair from a soil sample from The University of Michigan Campus". The new name may be invalid under the Code of nomenclature, since no type specimen is clearly indicated.]

Dixon, Dorothy. 1961. These are the champs. Am. Forests 67(1): 40-46; 48-50. 67(2): 41-47. [Account of "National Champion" trees as recognized by the American Forestry Association, including 31 from Michigan. See Mich. Bot. 1: 89. 1962.]

Elliott, Jack C. 1960. Additions to the flora of Kalamazoo County, Michigan. Am. Midl. Nat. 63: 246-247. [One form and 16 species added to the flora by Hanes and Hanes. One of these, *Polygonatum canaliculatum*, is not an addition at all, having been included by Hanes under the correct name, *P. commutatum*.]

Fouch, William R. 1962. Mast crops and fox squirrel populations at the Rose Lake Wildlife Experiment Station. Papers Mich. Acad. 47: 211-217. [Includes data on acorn and hickory nut production near Lansing, 1956-1959.]

Gebben, Allan I. 1961. Ecological aspects of the local occurrence of common ragweed [Abstract]. Bull. Ecol. Soc. Am. 42: 94. [Abstract of report on work in Washtenaw Co.]

Gillis, William T. 1960. Taxonomic problems in poison ivy. Papers Mich. Acad. 45: 27-34. [Includes some observations in Michigan.]

Gillis, William T., William Ball, Sr., & William Ball, Jr. 1961. Pieris poisoning in zoo animals. M. S. U. Veterinarian 22: 24-26. [Poisoning in John Ball Park Zoo in Grand Rapids, caused by ingestion of leaves from this shrub.]

Gillis, William T., & Keith I. Bakeman. 1962. The disappearing sleeping bear sand dune [Abstract]. Bull. Ecol. Soc. Am. 43: 59. [Abstract of ecological study in Leelanau Co.]

Hagenah, Dale J. 1961. Spore studies in the genus Cystopteris, I. The distribution of Cystopteris with non-spiny spores in North America. Rhodora 63: 181-193. [Research initiated in northern Michigan, and Michigan plants included in discussion, citations, and map.]

Hiltunen, Jarl K. 1961. Some records of Michigan ferns and fern allies. Am. Fern Jour. 51: 40-42. [Records from Chippewa Co.]

Ireland, Robert R. 1960. Notes on Pogonatum alpinum in eastern United States and Canada. Bryologist 63: 46-50. [Map and citations indicate distribution of this moss in northern Michigan.]

Kilburn, Paul D. 1960. Effects of logging and fire on xerophytic forests in northern Michigan. Bull. Torrey Bot. Club 87: 402-405. [A study in Cheboygan Co.]

Lawton, Elva. 1961. A revision of the genus Rhabdoweisia. Bryologist 64: 140-156. [*R. denticulata* cited from Alger Co.]

Lersten, Nels R. 1960. A note on the sexual condition in Mnium spinulosum. Bryologist 63: 245-246. [Observations made in Michigan.]

Lersten, Nels R. 1961. A comparative study of generation from isolated gametophytic tissues in Mnium. Bryologist 64: 37-47. [Material studied was from "vicinity of the University of Michigan Biological Station, Pellston."]

Mühling, Gabriele N., & G. B. Wilson. 1961. The chromosomes of Podophyllum peltatum. Rhodora 63: 267-275. [Material studied from Oakland and Ingham counties.]

Root, Elizabeth Eichstedt. 1961. Hybrids in North American Gymnocarpiums. Am. Fern Jour. 51: 15-22. [Hybrid of our two species studied from Marquette Co. Plate 1 is unfortunately upside-down in the journal, not in the author's reprints.]

Sherff, Earl Edward. 1961. Bidens connata var. gracilipes Fern. in western Michigan. Rhodora 63: 145. [Occurrence of a coastal variety of this species in Kalamazoo & Muskegon counties.]

PROGRAM NOTES

MICHIGAN BOTANICAL CLUB

March 10: State Meeting, in Ann Arbor, with Huron Valley Chapter as host. Details will be sent later; save this date.

SOUTHEASTERN CHAPTER, Michigan Botanical Club

March 1-10: Visit the chapter's exhibit and sales booth at the flower show in Cobo Hall, Detroit.

HURON VALLEY CHAPTER, Michigan Botanical Club

January 21: Professor Volney Jones speaks on plants used by Indians.

February 18: Professor Rogers McVaugh speaks on botanizing in Mexico.

MICHIGAN AUDUBON SOCIETY

January 25-26: Annual Meeting, Delta College

May 17-19: Spring Campout, Island Lake State Park

AUDUBON WILDLIFE FILMS

Presented by Detroit Audubon Society, University of Michigan Extension Service, and the National Audubon Society, co-sponsored by Cranbrook Institute of Science, Detroit Institute of Arts, and Wayne State University. Rackham Memorial Auditorium, Detroit (admission by ticket only), 7:00 & 9:00 p.m.:

February 2: ''Alberta Outdoors,'' Edgar Jones

March 9: ''Waters and Wildlife,'' Roy E. Coy

April 6: ''Subantarctic Isle,'' Alfred M. Bailey

May 18: ''The Living Wilderness,'' Charles T. Mohr

Editorial Notes

Since the earliest days of the Michigan Botanical Club, there has been talk of a poster project. We are grateful to Mrs. Siddall, whose labors brought success to the present project, for consenting to tell us about it on pages 27-28. Plans are to reprint an ample supply for the current year, as well as to seek new poster designs for the future.

We are likewise grateful to Professor A. G. Richards for his generous response to our invitation to share some of his X-ray pictures of flowers with our readers. Apart from the inherent beauty of these representations, there are suggestions for a means of study of vascular tissue and other structures.

Now that THE MICHIGAN BOTANIST is on a definite schedule of four issues per year (January, March, May, October), it should be mentioned that the deadline for material for this page is normally five weeks before the first day of the month of issue.

The date of mailing of the previous number (Vol. I, No. 2) was August 16, 1962.

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THE
MICHIGAN BOTANIST

March, 1963

THE MICHIGAN BOTANIST—Published by the Michigan Botanical Club four times per year: January, March, May, and October. Application to mail at second-class postage rates is pending at Ann Arbor, Michigan.

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All editorial correspondence and manuscripts should be sent to the editor in chief. Subscriptions and inquiries regarding them (from those not members of the Michigan Botanical Club) should be sent to the circulation manager, Mrs. Roberts, making all remittances payable to "The Michigan Botanist."

Manuscripts intended for publication should be neatly typed, double-spaced. Photographs should show good contrast and detail and be printed on glossy paper. In the effort to achieve uniformity in matters of style and balance in contents, the editors reserve the right to edit all material for publication. Authors should guide themselves by the style in current issues. Manuscripts should be carefully prepared and checked for accuracy before submission, as our method of printing does not include a proof which can be sent to authors. Authors of more than two pages of print in an issue will receive, if requested in advance, five copies of that issue. Arrangements for extracted reprints may be made through the editor.

THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora and to establish suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Inquiries regarding membership may be directed to the state secretary or, from those residing where there is a chapter, to the appropriate chapter secretary. (The Southeastern Chapter is centered in the Detroit metropolitan area; the Huron Valley Chapter, in Washtenaw County; and the Northwestern Chapter, in the northwestern Lower Peninsula.) Dues are modest, but vary slightly among the chapters; in all cases, they include subscription to THE MICHIGAN BOTANIST for the succeeding calendar year.

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PALYNOLOGY

With Special Reference to Palynological Studies in Michigan

Alan Graham
Department of Botany, The University of Michigan

The term palynology was introduced in 1943 by H. A. Hyde and D. A. Williams. It is derived from a Greek word meaning fine dust, and includes all studies concerned with pollen and spores. Since palynology can be used in a wide variety of investigations, Faegri (1956) has suggested that it be considered a technique rather than an independent field of study.

For convenience, the study of pollen and spores can be considered from three points of view: Their function, their structure, and their application or use.

THE FUNCTION OF POLLEN

The essential role of pollen grains in plant reproduction has been known for almost 5000 years. The ancient Assyrians were aware that trees of the date palm (*Phoenix dactylifera*) were of two kinds. One produced a fine yellow dust that was released to the wind and the other bore the dates. They also knew that the dust, or pollen, had to come into contact with the date-bearing trees before the desired fruit would be produced. The Assyrians discovered that by collecting the pollen and shaking it on the date palms, they could increase the yield of fruit. Assyrian bas-reliefs have been found in which cherubim are depicted pollinating the date palm, and according to Zirkle (1935) the Temple of Solomon, built between 1012 and 1007 B.C., was engraved with alternating cherubim and date palms. During the time of Hammurabi (2000 B.C.) records of business transactions show that the staminate inflorescence of the date palm was a common item of commerce. The Assyrians were not only the first known people to have practiced artificial pollination, but their writings reveal that they considered the pollen-producing plants male and the date-producing plants female. They are thus credited with the original recognition of sex in plants.

Although the existence of sexuality in plants, and the essential role of pollen in reproduction, was appreciated by the Assyrians, the concept was lost after a few centuries and we find the Greek philosophers not only denying sex in plants, but speculating that the sole function of pollen must be to provide food for visiting insects. It was not until 1694, when Rudolph Jacob Camerarius wrote his famous letter, "De Sexu Plantarum," that the concept was revived and studies of plant reproduction placed on a sound foundation. Today it is known that the primary function of pollen is the transport of sperm nuclei from the anther to the stigma of the pistil.

THE STRUCTURE OF POLLEN

The structure of pollen is related to its function as the sperm-bearing element in plant reproduction and to its method of dispersal. From the functional standpoint, the internal contents of the pollen grain are protected from desiccation during transport by a pollen wall, called the *exine*. Once the grain contacts the stigmatic surface, a pollen tube germinates, carrying the sperm nucleus eventually to the ovule. The pollen tube germinates through thin places in the exine called *apertures*. These apertures may be *pores* or furrows (also called *colpi*, sing. colpus). The apertures are capable of contracting or expanding in accommodation to atmospheric changes which affect pressures within the pollen.

The structure of pollen and spores is also related to the mode of transport from the anther to the stigma. The most common means of transport are water, wind, and animals, particularly insects. Pollen carried by water often lacks a well-developed exine since desiccation of the internal contents is not a problem. The pollen of wind pollinated plants is often smooth, small, and dry so that it does not stick together in clumps. It may also be provided with certain specialized structures, such as the air bladders in pine, spruce, and fir pollen. The pollen of insect-pollinated plants is usually larger, sticky, and is often provided with spines that attach to the legs of insects.

The color of pollen may be yellow, orange, red, green, or blue. Shape variations include spherical, triangular, oblong, reniform, and irregular. The pollen grains may be individual or united into dyads, tetrads, or polyads. The aperture number ranges from one to over twenty and the apertures may be arranged about the equater, scattered over the surface of the grain, or confined to one hemisphere. The size of pollen ranges from less than 15 microns to over 100 microns (.015 - 0.1 millimeter).

This brief consideration of pollen structure serves to illustrate an important point: Although microscopic in size, pollen grains and spores possess a sufficient number of characteristics to allow considerable

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EXPLANATION OF PLATE 1. 1. *Anemia rutifolia*, a fern spore. The triradiate scar is characteristic of the spores of many ferns. 2. *Polygala fruticosa*. This polar view shows the numerous colpi, one of which serves as the place of exit for the pollen tube. 3. *Bombax ellipticum*, a tropical plant. Note the short colpi and their position between the apices of the triangular grain. Usually the apertures are situated at the apices (cf. fig. 6). 4. *Pachysandra procumbens*, a plant of eastern Asia. A pollen type of this kind has recently been found in the Miocene of western United States, approximately 18,000,000 years old. This grain is *periporate*, that is, the pores are several and scattered over the surface. 5. *Albizia julibrissin*, a subtropical plant often cultivated in warmer parts of the country. It belongs to the legume family, one tribe of which is characterized by having the pollen grains united into *polyads*. 6. *Myrica pennsylvanica*, a plant of northeastern North America, related to the wax myrtles. This grain is typical of pollen that is distributed by the wind. Note the small size and smooth surface. This grain is *triporate*.

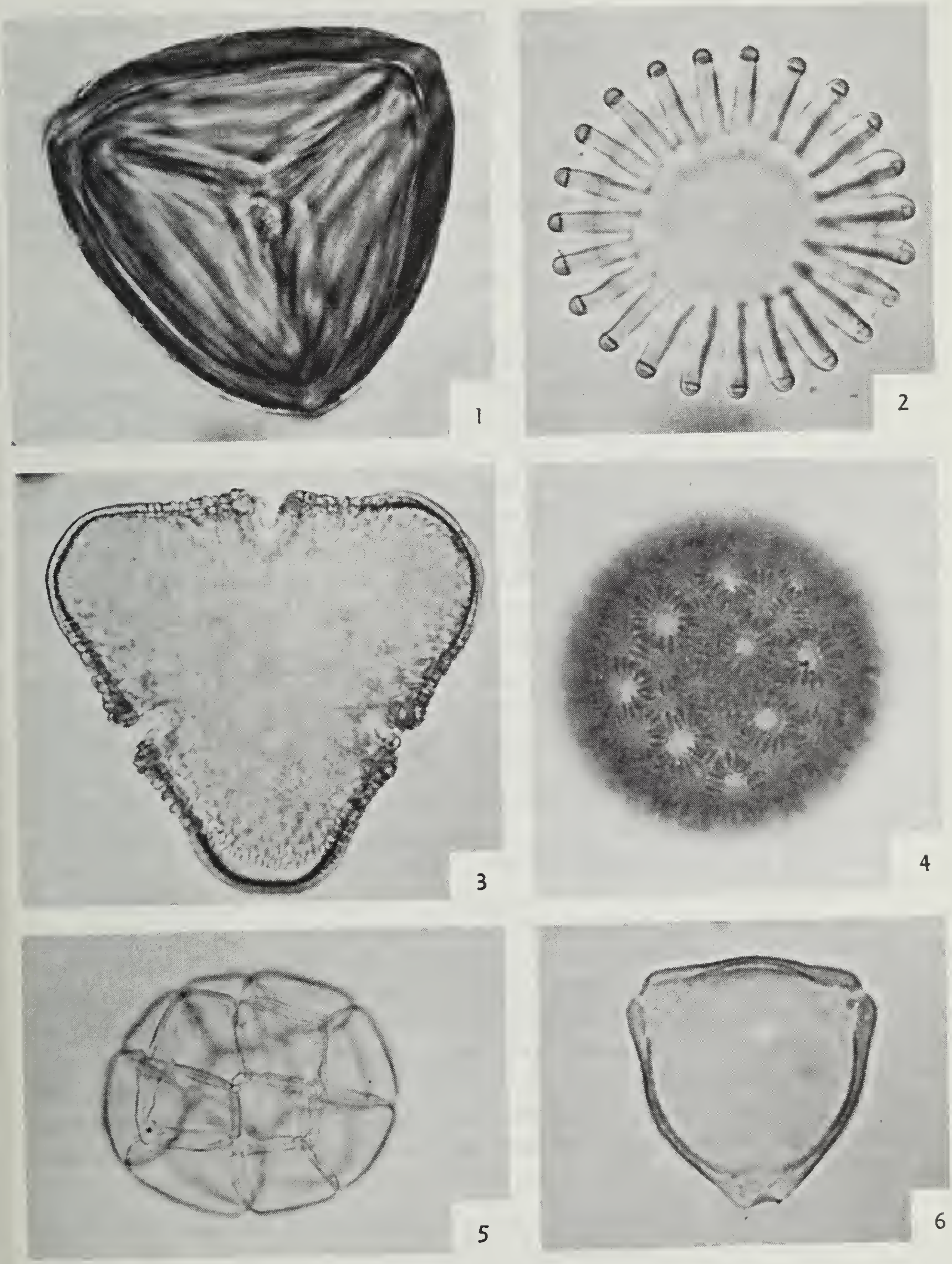

PLATE 1.

Modern Pollen and Spore Types
(Magnified, mostly about 100 times)

Explanation on facing page.

variation in morphology. This fact serves as the basis for one of the important principles of palynology—the morphology of pollen grains and spores varies to the extent that many plants are characterized, and can be recognized, by their pollen. This principle is basic to consideration of the application or use of pollen and spores. In the following section the use of pollen will be illustrated. As far as possible, examples will be taken from work concerned with the botany, geology, and archeology of Michigan.

THE APPLICATION OF POLLEN AND SPORE DATA

Pollen Morphology and Plant Taxonomy—Taxonomy is concerned with the relationship between plants and plant groups as reflected by the degree of similarity or difference between them. In order to determine these relationships the taxonomist uses a number of different characters. One of these is the morphology of pollen.

The first person to suggest that pollen could be used as a taxonomic character was Robert Brown (also discoverer of the nucleus): "I am inclined to think, not only from its consideration in this family, but in many others, that it [the pollen] may be consulted with advantage in fixing our notions of limits of genera" (quoted from Wodehouse, 1935, p. 38). This statement was made in 1809,concerning the family Proteaceae. In the 155-year period that has elapsed, studies of pollen morphology have become widely used in plant systematics.

As an example from Michigan, the work of Ann Waterman (1960a) may be cited. Miss Waterman, at Michigan State University, studied the pollen of 50 species of the Labiatae (mint family) growing in Michigan and of 5 cultivated species. A key was prepared for the identification of 49 of these pollen types. Two major groups of Labiatae pollen types were recognized: tricolpate and hexacolpate. The former were found to be binucleate and the latter trinucleate. Most important for present considerations, however, was the fact that variations in pollen morphology were evident within each group. Moreover, these variations were generally consistent with taxonomic groupings and tended to support a systematic revision proposed earlier (Waterman, 1960b). Other investigators have used pollen in a similar manner and it is interesting to note that Engler and Prantl (1897) make initial subdivisions of the family Acanthaceae on the basis of pollen characters (cf. figures on pp. 281-282).

Aeropalynology—It was noted earlier that one of the principles upon which the technique of palynology is based is that pollen and spores vary in morphology. Another principle is that the pollen and spores are released to the atmosphere and fall as the 'pollen and spore rain.' This fact, although important for the application of pollen data to fossil studies, is the source of much discomfort for hayfever sufferers. The National Institutes of Health is currently sponsoring research at various universities in an effort to find a cure for this ailment. At the

University of Michigan three departments are involved in the study. The Medical School is investigating the biologic and allergenic aspects of pollen grains, particularly *Ambrosia* (ragweed). The Department of Meteorology is concerned with the development of suitable techniques for accurately sampling the atmosphere for pollen. Members of the Department of Botany are studying the taxonomy and ecology of ragweed, and are counting the number and kinds of pollen in the atmosphere from samples taken by the meteorologists. The funds and personnel involved in this project throughout the nation, together with the funds spent each year by allergy sufferers for relief, are witness to the importance of pollen and spores as aeroallergens.

Melitopalynology—This phase of palynology deals with pollen in food and drugs. One of the common 'pollen products' is honey. This food is rated according to its quality and purity, and priced accordingly. For example, honey made from one particularly desirable variety of clover may be of better quality than that made from others or from a mixture of pollen from several different species. The Food and Drug Administration often examines the pollen in commercial honey to insure that the proper grade has been assigned and that standards of that grade are maintained.

Pollen and Spores as Fossils—Two of the principles of palynology have already been considered. The application of pollen and spore data to problems of paleontology are based on four additional ones. First, pollen and spores are capable of being preserved as fossils. This is due to the fact that the exine is extremely resistent to decay. Second, most plants produce either pollen or spores. Third, plants are limited as to the number of ecological habitats in which they can grow; thus, certain aspects of the paleoenvironment can be determined from the fossil microflora. Finally, suitable techniques are available for the recovery of plant microfossils from various sediments.

The technique of pollen analysis, a branch of palynology dealing with fossil spores and pollen, is based upon these principles. One of the most widespread uses of pollen and spores has been in the study of Pleistocene climatic changes and the response of vegetation to these changes. The Pleistocene Epoch extends from the present back about 3 million years. In addition to being the epoch during which man evolved, it was also the time during which much of northeastern North America, and other parts of the world, were subjected to four or five major glacial advances. As the glaciers retreated numerous lakes were formed, some of which slowly filled with plant debris. The result was the creation of numerous peat bogs. The acid and anaerobic conditions existing in the bogs were admirably suited for the preservation of quantities of pollen grains and spores. By extracting and counting the pollen from a given level it is possible to determine the more dominant members of the surrounding vegetation, and by superimposing counts from successive levels it is also possible to detect changes in the vegetation. One of the first examples of such a study is that of Lennart von Post, a Swedish geologist. Von Post studied the pollen of peat bogs in southern Sweden and reported his results in 1916 before the Sixteenth Meeting of Scandinavian Naturalists in Oslo. Since von Post's presentation several thousand papers have been published on fossil pollen and spores.

It is interesting to note how close a Michigan botanist came to developing the same method 5 years earlier. The following statement by H. A. Gleason is taken from an article in the Bulletin of the Ecological Society of America for 1953:

"The past history of our vegetation could be learned with much greater accuracy if we had plenty of evidence from fossils. It seemed that we might find them in peat bogs. So in 1911 Fred A. Loew, then a graduate student at Michigan, was set to work with a soil borer to dig up the fossils in a bog at the Michigan Biological Station. He got peat from all depths, washed it thoroughly, and in it we found just one recognizable fossil, a seed of *Nuphar advena.* Neither of us imagined that we had washed away many thousands of perfectly fossilized pollen grains."

The first Pleistocene pollen study in the United States was made in 1930 by Paul B. Sears. As a result of this pioneer work, and subsequent investigations, the Late-Pleistocene history of vegetation in northeastern North America is fairly well known. As the glaciers retreated, barren areas were exposed that initially became colonized by herbaceous vegetation. Whether this vegetation represented tundra or not is uncertain, but tundra vegetation apparently did exist marginal to the glaciers of northwestern Europe. This treeless vegetation was subsequently replaced by spruce and fir, and, with further climatic

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EXPLANATION OF PLATE 2. 1. *Polygonum longistylum*,, a plant belonging to the buckwheat family. The coarse reticulum is composed of ridges (*muri*) and low areas (*lumen*). Within the lumen are pores, and since there are several of them, this grain, like *Pachysandra*, is periporate. 2. *Carya illinoinensis.* The pecan and the hickory, both members of the genus *Carya*, have pollen of this type. The grain is *triporate*, but the pores are not situated exactly on the equator. As evident in the photograph, the pores are slightly above the equator and in one hemisphere. In *Juglans* (the walnut), a member of the same family, there are several pores but these are scattered over the surface of one hemisphere only, the other half of the grain containing no pores. Grains of this type are said to be *heteropolar.* 3. *Bifora americana*, a member of the Umbelliferae, the carrot family. The dumb-bell shape of the grain is characteristic of the pollen of the Umbelliferae. In this case a pore is situated in the center of the long colpi, and the grain is *tricolporate.* 4. *Pinus contorta.* The pollen of pine is adapted to wind pollination, as evidenced by the air bladders. The furrow is located on the lower side of the body, between the bladders. 5. A fossil fungal spore from the Miocene of Oregon. 6. *Sequoia gigantea*, the giant sequoia. The pollen tube germinates from the tip of the *papillus.* 7. *Triletes rotatus*, a species described by H. H. Bartlett from the Carboniferous coal pebbles around Ann Arbor.

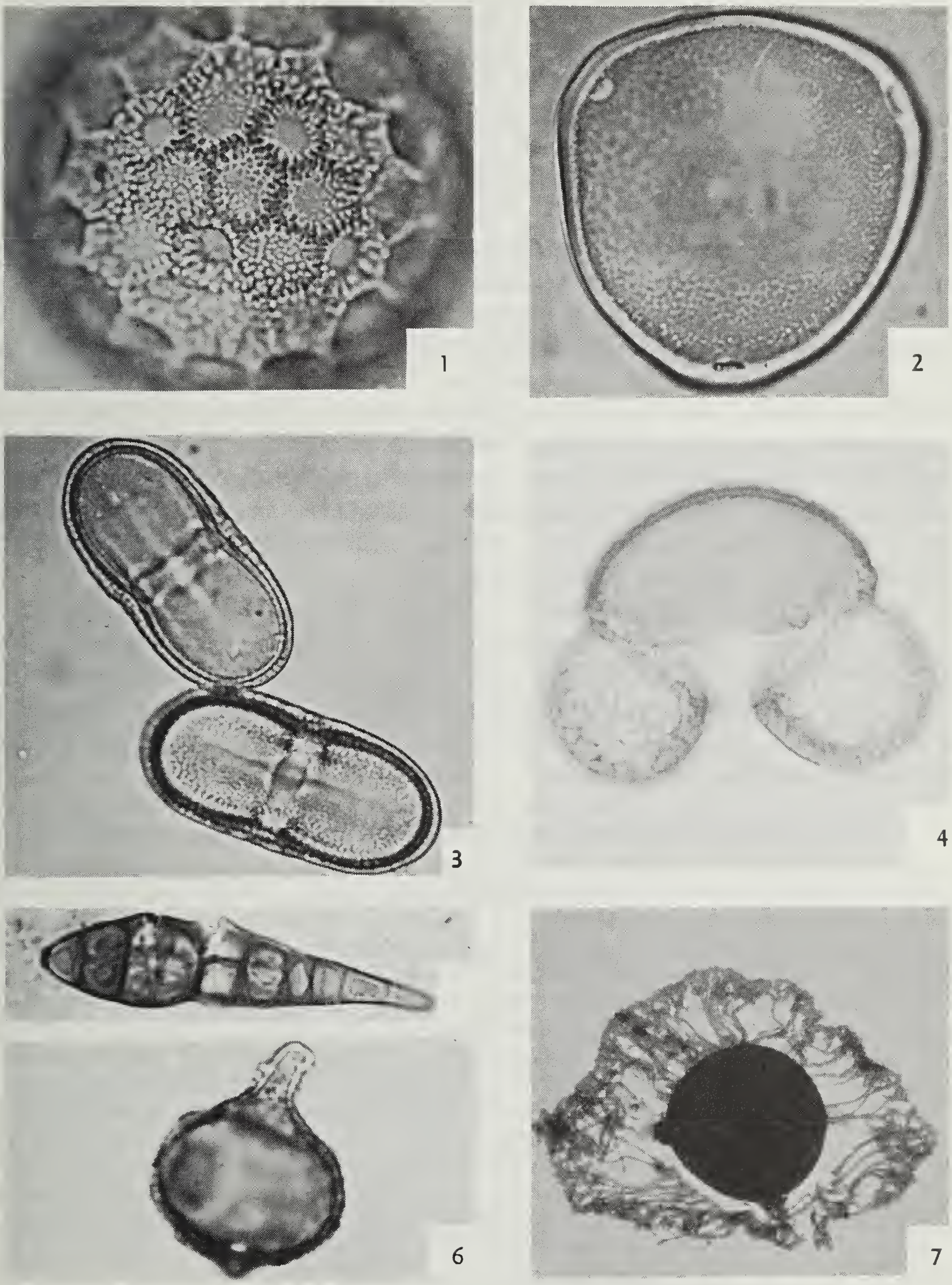

PLATE 2.

Modern and Fossil Pollen and Spore Types
(Magnified, mostly about 100 times)

Explanation on facing page.

amelioration, by the deciduous forest that now characterizes much of northeastern United States.

Several contributions have been to the elucidation of Late-Glacial vegetation by investigators studying sediments from Michigan. These include those of Andersen (1954), Potzger (1942, 1946, 1948, 1954), Wilson and Potzger (1943), and Zumberge and Potzger (1955, 1956). Benninghoff (1960) has evaluated the modern pollen rain in comparison with regional vegetation.

Tertiary pollen and spore studies have not been made on Michigan deposits because sediments of that age are not exposed in the state. Paleozoic rocks are exposed, however, and it was from fragments of Pennsylvanian coals in the glacial drift at Ann Arbor that one of the first published Paleozoic spore studies for the United States was made. The investigator was the late Harley Harris Bartlett. The spores represented the genus *Triletes*, which were presumably produced by a species of *Lepidodendron*. Since Bartlett's publication, Paleozoic spore studies have found wide application, particularly in the correlation of coal seams. Paleozoic spore studies in Michigan include those of Arnold (1950, 1961), Bartlett (1929a,b), and Chaloner (1954).

A final example of the use of palynology concerns its application to studies in archeology. Several sites in Michigan are currently being investigated, but as yet no published results are available. For this reason a classic study made in Denmark by Dr. J. Iversen will be used as an example. The following account is quoted from Gray and Smith (1962):

> One of the most dramatic applications of pollen analysis to archaeological interpretation was made by Professor J. Iversen in Denmark. Although it is probable that Palaeolithic and Mesolithic man had little influence on the vegetation where he lived and that forest development during those times can be ascribed wholly to natural causes, Iversen's researches documented Neolithic man's dominance over his local environment. Observing pollen diagrams from several sites dating to the transition from Atlantic to Sub-Boreal (ca. 2500 B.C.), Iversen noticed that just when alder, birch, pine and Mixed Oak Forest were at their maxima, pollen values for elm decreased markedly, as did those for ivy, while ash pollen increased, indicating a change to drier and more continental conditions. Immediately afterward the pollen curves show a striking and peculiar change: oak, linden, elm and ash all decline suddenly and steeply. Along with this change there occurs a layer of charcoal, above which the forest trees again gradually increase, although birch and alder increase most rapidly and hazel reaches a pronounced maximum. Closely connected with falling or minimum tree-pollen curves is the sudden rise, almost three-fold, of herb and shrub pollen, including small but sustained quantities of pollen of cultivated plants and a continuous record of plantain and wormwood, both of which are weeds associated widely with human disturbance of natural vegetation.
>
> The inference is strong that these conditions indicate the introduction of agriculture by Neolithic people, who came into the northern forests soon after the climatic change, cleared the forests with axe and fire, and cultivated cereals. Strong evidence against explaining these phenomena by climatic change is provided by the decline of all forest tree-pollen almost in

equal proportion and not selectively, followed by a typical forest regeneration with rapid reestablishment of pioneer species (alder, birch, hazel), and the simultaneous appearance of plantain, wormwood and cereals which point to the presence of human agriculturists, who probably also set the fires as a means of clearing the land.

To determine whether Neolithic man could have felled large areas of forest trees, Iversen and his colleagues experimented on similar trees with actual Neolithic axes, and proved beyond doubt that such a feat was easily within the ability of small groups of men even so meagerly equipped. They then burned the area, and observed that the subsequent changes in vegetation closely simulated those of the Neolithic as evidenced in the pollen diagrams. What Iversen first saw in Denmark has been noted at numerous other sites in northern Europe and the British Isles, so that the introduction of agriculture over the entire area, probably at about the same date, is now well established.

Considering that extensive use of pollen and spores as fossils dates back only to 1916, the precision with which Iversen was able to interpret past vegetational history via the pollen diagram is remarkable. Many such interesting studies are underway and many other problems await investigation.

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THE DISAPPEARING SLEEPING BEAR SAND DUNE

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Department of Natural Science and Department of Civil Engineering,
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Thirteen years have elapsed since the late Dr. Frank Gates published his description of the changes in the physiognomy of the Sleeping Bear Sand Dune in Leelanau County, Michigan (Gates, 1950). For centuries, the Sleeping Bear has been a landmark, storied in Indian fables, and, early in the history of Michigan, cited as a survey point. Because this dune lends itself well to periodic examination of the forces of wind erosion and the vegetational changes which they cause, this paper is submitted as an additional chapter in the biography of the dune. Unfortunately, measurements to date have been few, and at irregular intervals.

The Sleeping Bear Sand Dune is perched on the Sleeping Bear Plateau, which forms cliffs 140 meters high at the Lake Michigan shore in T. 29 N., R. 15 W., Sec. 36. The Dune is located precisely at 44° 52' 22" N. lat., 86° 04' 07" W. long. The Bear itself (sometimes called "The Pinnacles") is one mile west of the mounds of sand near Glen Lake which are climbed for sport by thousands of tourists each summer. To the less hardy, who do not persevere long enough to traverse the rolling dunes to Lake Michigan, these sands are believed to be the Bear. The source of the vast quantity of sand that moves inexorably eastward toward Glen Lake is the eroding Bear and the cliff on which it stands. The origin of such a perched dune is discussed by Dow (1938).

These cliffs are morainal in nature, all part of the Manistee Moraine, formed by the Wisconsin glaciation at the final advance of the Port Huron substage. The various lake stages which have followed glaciation have left shore lines and beaches. Several of these abandoned beaches are observable from Sleeping Bear Point southward (U.S. Dept. of Interior, 1961). The terrace cut by Lake Algonquin at 185 meters has been uplifted to about 194 meters by crustal rebound. Lake erosion varies in intensity over periods of a few years along the morainal cliffs, and is now extremely active for six kilometers along the Sleeping Bear Peninsula. This erosion brings eroded till particles and sand from the lake, scattering them across the surface of the moraine and building a system of dunes on which dune vegetation prevails.

THE DUNE BEFORE 1950

Gates (1950) suggests that the doom of the Bear began with the path up from the lake used during one of the many lake surveys (of which several were made). (The field sheets which are available from the U.S. Army Corps of Engineers, Lake Survey, District Office in

Detroit are here given by date: 1843, 1-40; 1854, 1-125; 1860, 1-243; and 1906, 1-1116. They show that the height of the dune was constant on these occasions at 150 meters above Lake Michigan.) It is more likely that the path mentioned above simply triggered the erosion of the Bear and that the eroding bluffs (already active and denuded of vegetation in 1915 [Fig. 9] before the Bear began to move) were the primary cause. Sand movement on the Bear, where full force of the winds off the lake can be felt, is made obvious to the observer by the sand blasting against his body on any windy day. The death of some of the trees must be attributed to scouring by the sand even into the heartwood, especially during winter storms. Fig. 4 shows the effect of sandblasting on a cottonwood in early spring 1958. This tree did not leaf out in 1958 and it disappeared by 1959.

Waterman (1927) and Gates (1950) have traced the movement and changes of the dune from about 1915 to 1949. Changes were recorded photographically about 1915, in 1928, 1937, and 1948. Gates noted that the crest of the dune had dropped from 48.48 meters above the moraine to 33.53 meters between 1935 and 1949. According to all the lake surveys through 1906, the original height must have been about 70 meters. The Coast and Geodetic Survey marker that once rested at the crest of the dune has not been located for a number of years. The station, established in 1932, was a standard station disk cemented into the top of a 12-foot section of three-inch pipe, sunk 11 feet into sand, filled and anchored in a mass of concrete. Local residents claim that the last person who could find it intact was Gates himself. It is believed to have fallen into the lake. The authors searched diligently for it after calculating its position from the Coast and Geodetic reference mark set in a boulder on the plateau, but could not find it. We calculate that, if it remained motionless without shifting as the dune eroded, it would now be suspended about 10 meters in the air!

Gates described a conifer-hardwood forest on the northwest quadrant of the dune in 1928, consisting of *Thuja occidentalis*,[1] *Acer saccharum*, *Tsuga canadensis*, and *Sorbus* sp. By 1949, part of this forest was still standing or leaning. Plant cover on the northeast side consisted in 1928 more of shrubs and vines than trees: *Cornus stolonifera*, *Toxicodendron radicans* var. *rydbergii*, *Celastrus scandens*, *Vitis vulpina*, some *Betula papyrifera*, and *Populus deltoides*. The southeast quadrant he describes as heavily vegetated with *Thuja*, *Tilia americana*, and *Abies*, with *Cornus*, *Prunus virginiana*, *Smilacina stellata*, and *Toxicodendron radicans* var. *rydbergii* intermixed. By 1949 this forest was being invaded by *Vitis* and *Celastrus*, especially as sand became denuded of vegation.

The west side, toward the prevailing winds, has undergone the

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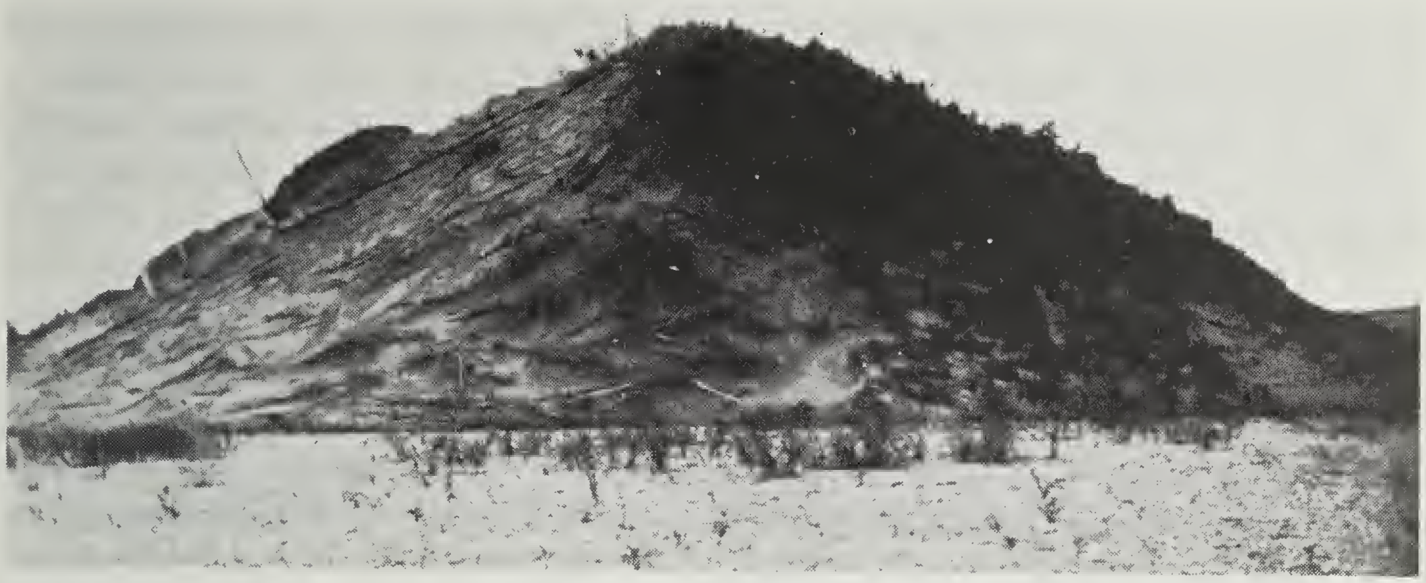
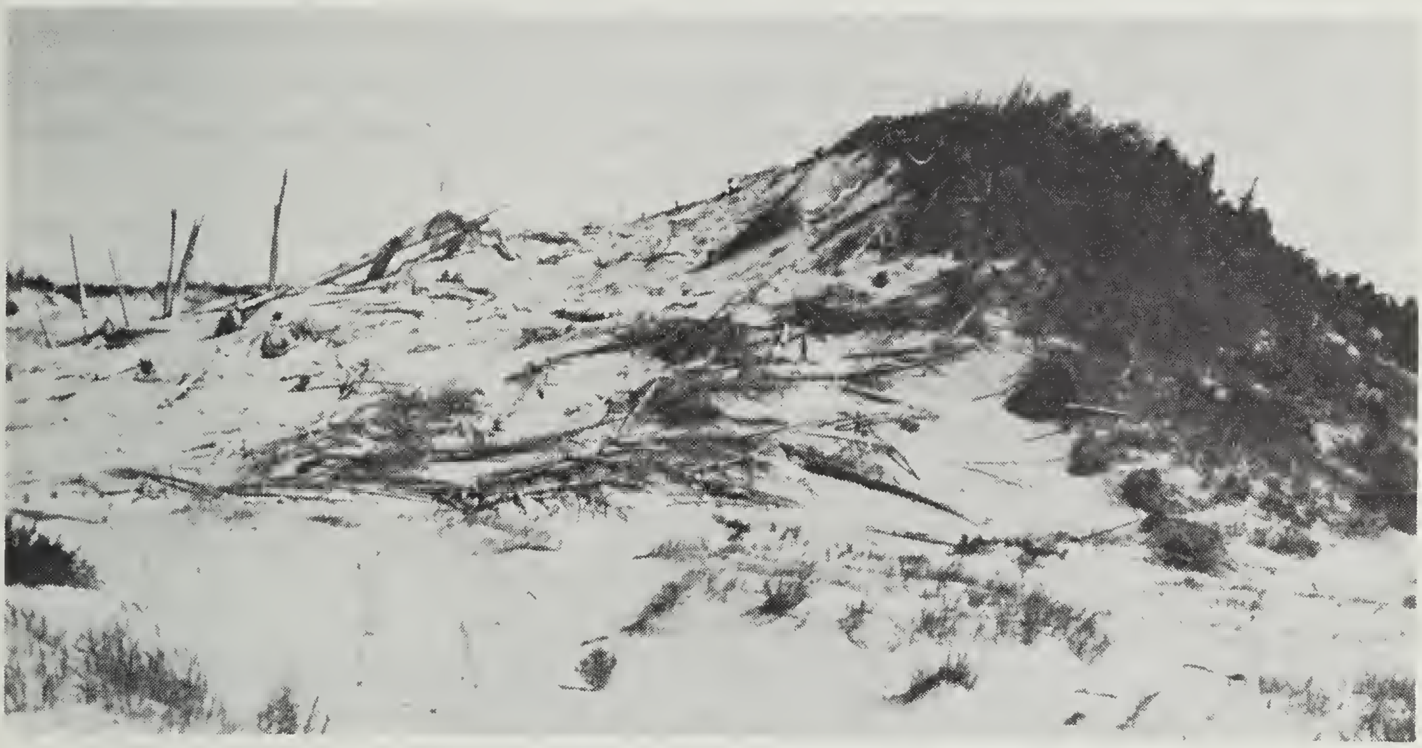
[1] All binomials agree with Fernald, 1950, except *Toxicodendron radicans* (L.) Kuntze var. *rydbergii* (Small ex Rydberg) Erskine (see Gillis, 1962). Voucher specimens of all plants mentioned are deposited in the herbarium of Michigan State University.





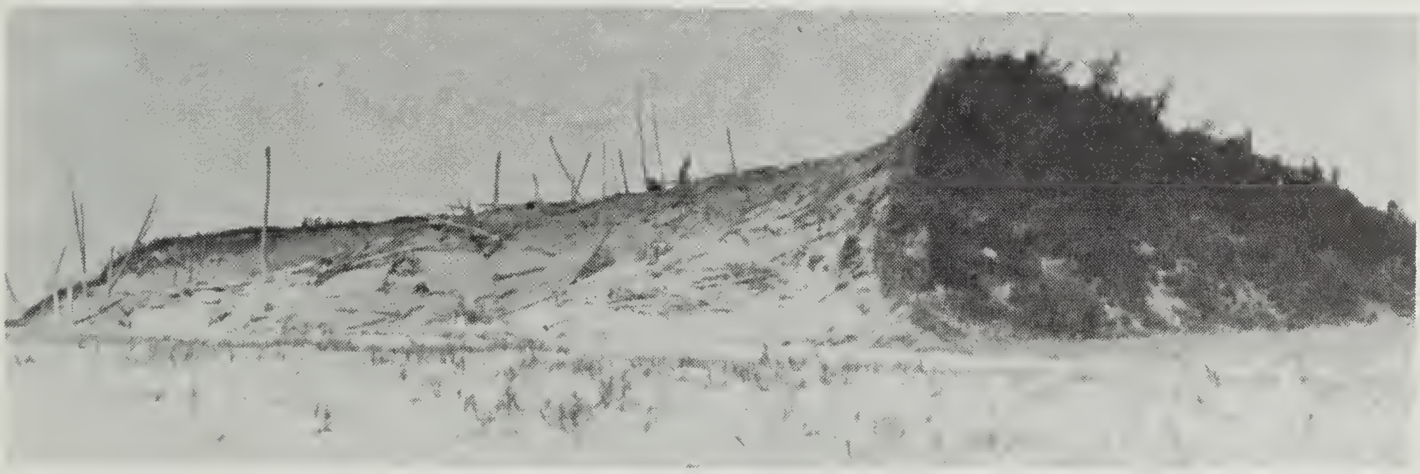


Fig. 1 (top). Looking north to Sleeping Bear dune. July 21, 1928. Photo by F. C. Gates. (Photographs repeated from Gates, 1950, were made available by his son, Dr. David M. Gates, of Boulder, Colorado.)

Fig. 2 (middle). Same aspect as Fig. 1, July 24, 1948. Also by Gates.

Fig. 3 (bottom). Same aspect as Fig. 1. August 12, 1961.

least vegetational change but the greatest erosional change since 1928. By that date there were no living trees in the southwest quadrant; only sandblasted snags projected above the sand. The sand here is loose and easily wind-blown. The physiognomy of this slope changes hour by hour, but became generally less steep between 1928 and 1949 as the sand wore down from the top (see Fig. 1-3).

THE DUNE FROM 1950 to 1961

The senior author first saw the Sleeping Bear Sand Dune in 1956 The center of the dune had become horseshoe-shaped (as seen by aerial photograph No. BEA-3-4, taken in 1938), since the wind had gouged much sand from the southwest quadrant. The slope has become steeper again recently because the base has been retreating faster than the sand which is piled above it. Or rather, the sand from the base is constantly being piled above it. The ghost forest of dead trees, bleached and blasted by the sand and weather, changes as the snags and logs are alternatingly buried and uncovered. A few trees stand straight, while others stand at odd angles resembling the ''drunken forests'' of the boreal taiga. (See Fig. 5.)

By 1961 a saddle had been worn through the center of the dune so that there was no longer a pinnacle. A wide swath of moving sand now cuts across the top of the dune, spilling down the northeast side. What had been a horseshoe is now two crests separated by a river of sand. The pinnacle is no longer a stationary point, but rather that portion of the dune's side which remains highest as the southwest face recedes. The northeast-facing spillway is the easiest side to climb for those traversing the plateau, and has been kept in a disturbed state by human feet. Within the last two years a new path has been worn on the north-facing side and another on the east-southeast side; sand is now spilling over here from the southwest also.

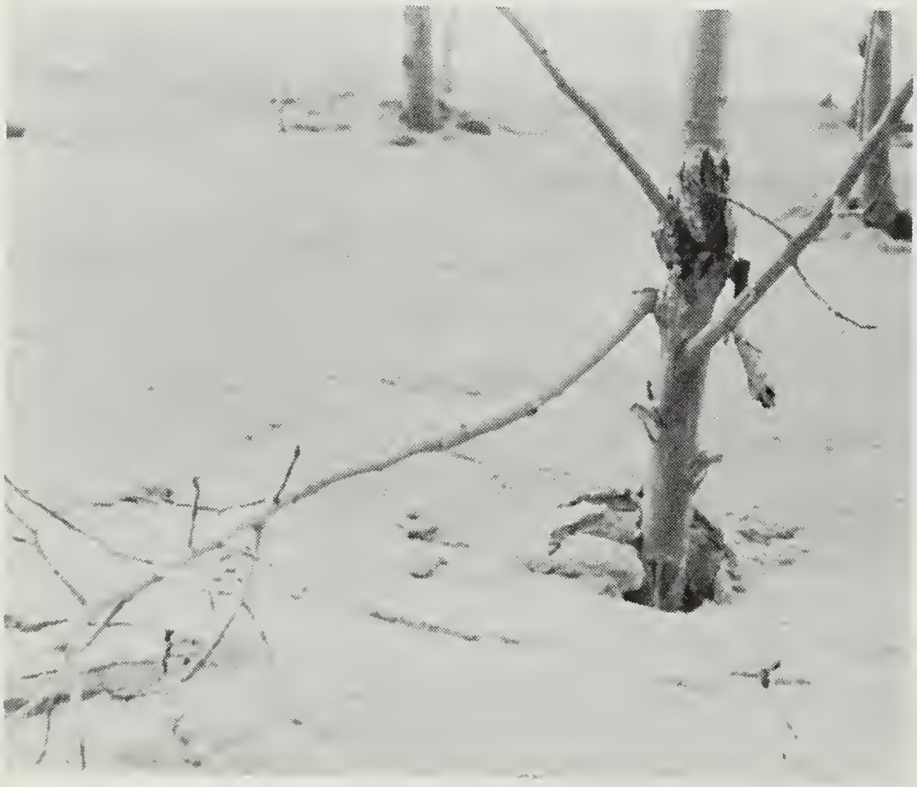


Fig. 4. Sand-blasted cottonwood on lee slope of dune. Early spring, 1958.

Changes in plants present on the Dune may be noted from year to year. A grove of cottonwoods (*Populus deltoides*) that once could be seen on the northeast face of the dunes was undercut and/or buried by 1961 (compare Fig. 7 with Fig. 8). A lone cottonwood now stands at the top of the northern hummock. *Tsuga, Abies,* and *Acer* no longer inhabit the dune. A clone of *Cornus stolonifera* that once rimmed the northeast crest disappeared between 1956 and 1959 as the sand movement here increased and the rooting foundation of the shrubs crumbled.

Our measurements were made by third-order leveling from the bench mark (P-88) on the bridge at Glen Lake, across the lake surface, and up the moraine across to the reference mark in the boulder north of the Bear. Leveling and triangulation were used to locate the top of the dune. The highest point was found at 40.14 meters (131.62 feet) above the plateau. (Our measurements were confirmed by triangulation onto the water surface of Lake Michigan, later verified as 580 feet (177 meters) for 12 August 1961 by the Lake Survey.) Either Gates' measurements for the top of the Bear (taken by altimeter readings) were in error (33.53 meters), or the dune has rebuilt some of its lost top. The latter is a distinct possibility, since *Ammophila breviligulata,* an ardent dune-builder, is actively growing at the top of the southern--and higher--hummock.

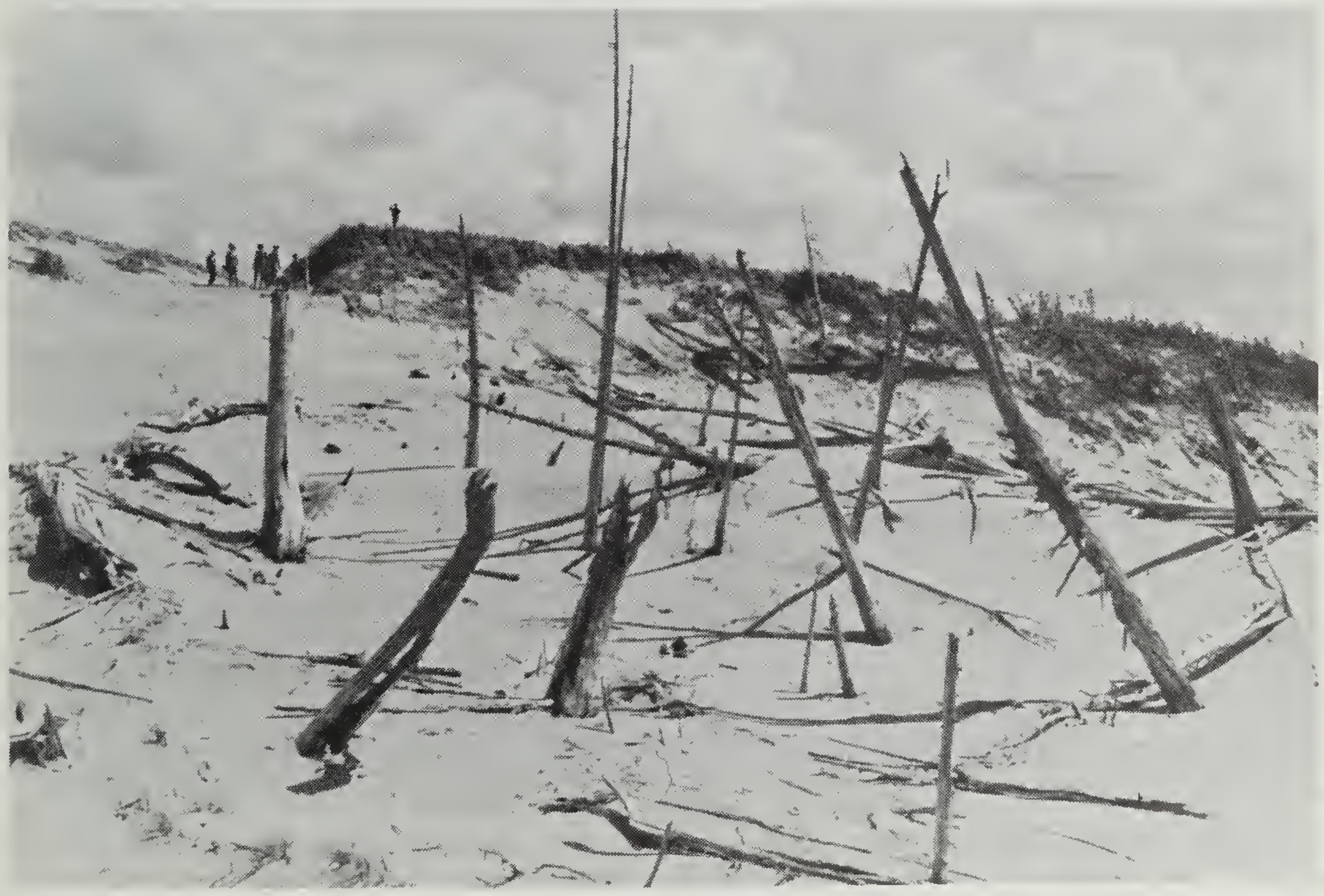


Fig. 5. View to the east, showing ghost forest on the Sleeping Bear dune. This central windsweep was the location of the pathway to the summit in 1932. A young boy stands at the highest point on the dune. August, 1961.

When the monuments were set by the Coast and Geodetic Survey thirty years ago, the marker on the Bear was 180° due south from the marker on the plateau. By 1950, the dune's highest point had migrated to 174°, a shift of 6° in 19 years. In 1961, it had moved to 169.75°, another shift of 4.25° in 11 years. Movement of the crest has apparently accelerated.

Gates mentions the noticeable retreat of the bluff. The boulder was 32 meters from the edge of the cliff when the marker was installed in 1932. The cliff eroded to 22.1 meters from the boulder by 1950. We measured the distance from the Coast and Geodetic Survey marker in the boulder due west to the cliff edge and found it to be 15.75 meters in August of 1961. The rate of erosion appears to be speeding up, as evidenced by the two, widely-spaced increments. Nevertheless, the fact is inescapable that the entire cliff has retreated 16.25 meters (53.3 feet) in less than 30 years!

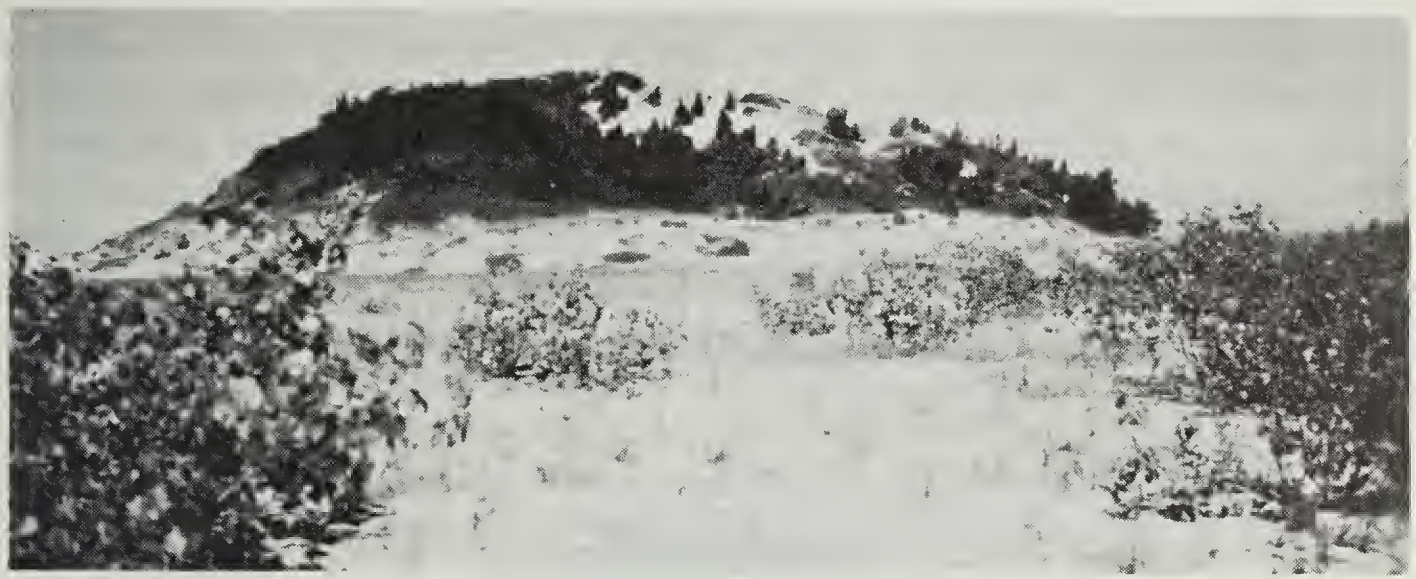
The southwest quadrant is still rapidly eroding and is characterized by a ghost forest. The southeast quadrant has a thick, almost impenetrable, *Thuja-Prunus* forest on it. *Toxicodendron radicans* var. *rydbergii* is found frequently as an understory sub-shrub. It also grows as close to the moving northeast-facing and spillway as any plant. Near the crest *Cornus stolonifera, Prunus pumila,* and *Viburnum acerifolium* are found with *Vitis vulpina* twining around all. Gates did not mention the *Viburnum* as being present on the dune.

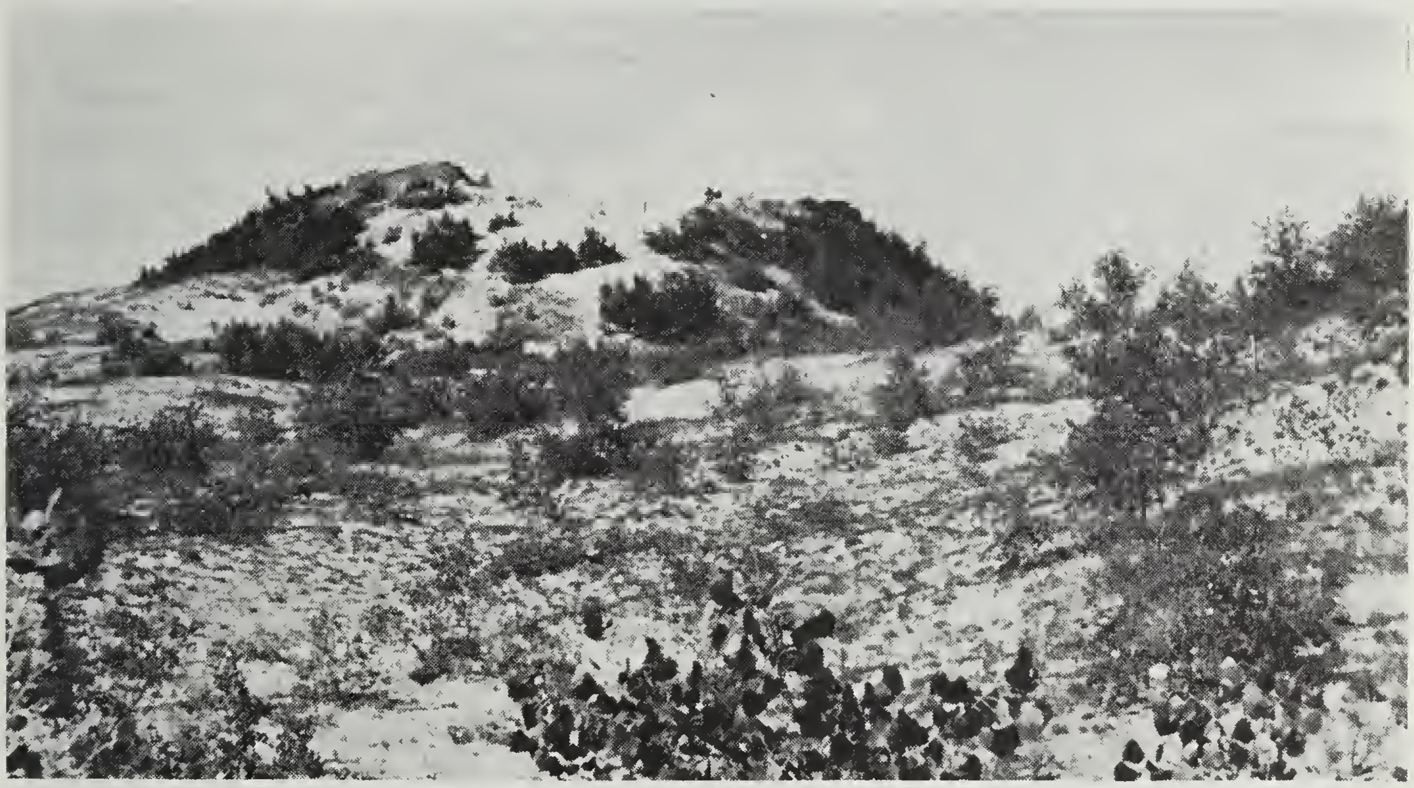
The northwest and northern sides still have *Thuja* and *Betula* with *Cornus, Celastrus,* and *Smilacina* near the top. There is an occasional plant of *Sambucus pubens.* Where sand movement is greatest on these sides, *Corispermum hyssopifolium, Aster laevis, Elymus canadensis,* and *Asclepias syriaca* are found. *Calamovilfa longifolia* is common near the base of the dune, whereas *Ammophila* is more common near the top. Most noteworthy is that no new tree species has invaded since 1928 and no evidence is available to show that any tree species have reproduced themselves from seed on the dune since that time. Several species are present which are not represented in the flora for several miles to the southeast (*Thuja occidentalis, Viburnum acerifolium, Celastrus scandens*).

VEGETATION ON THE PLATEAU

We also recorded the vegetation on the general dune surface of the plateau. Five kinds of vegetation are distinguished, characterized by the type of site on which each occurs: those on the depositing sands that encroach upon Glen Lake, bare areas of moving sand, the more or less stabilized small dune crests, stabilized lows among dunes, and open morainal barrens.

The depositing sands, which are best known to tourists, were measured by triangulation for future reference. The slope of this first plateau of sand is kept constantly free of vegetation by climbing tourists. It stands at 40.73 meters 133.6 feet) above the old field and





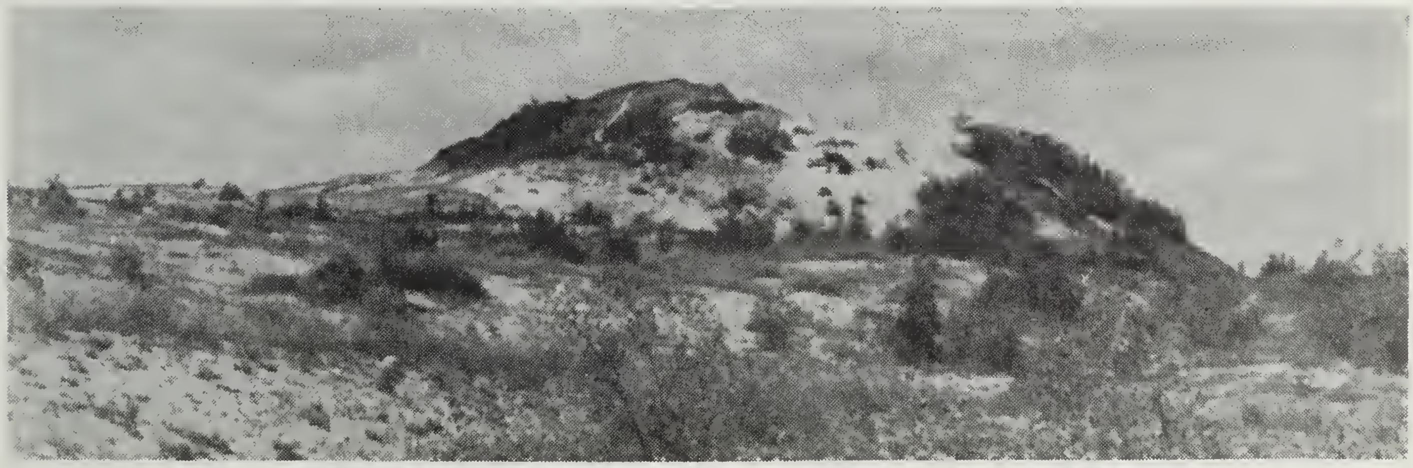
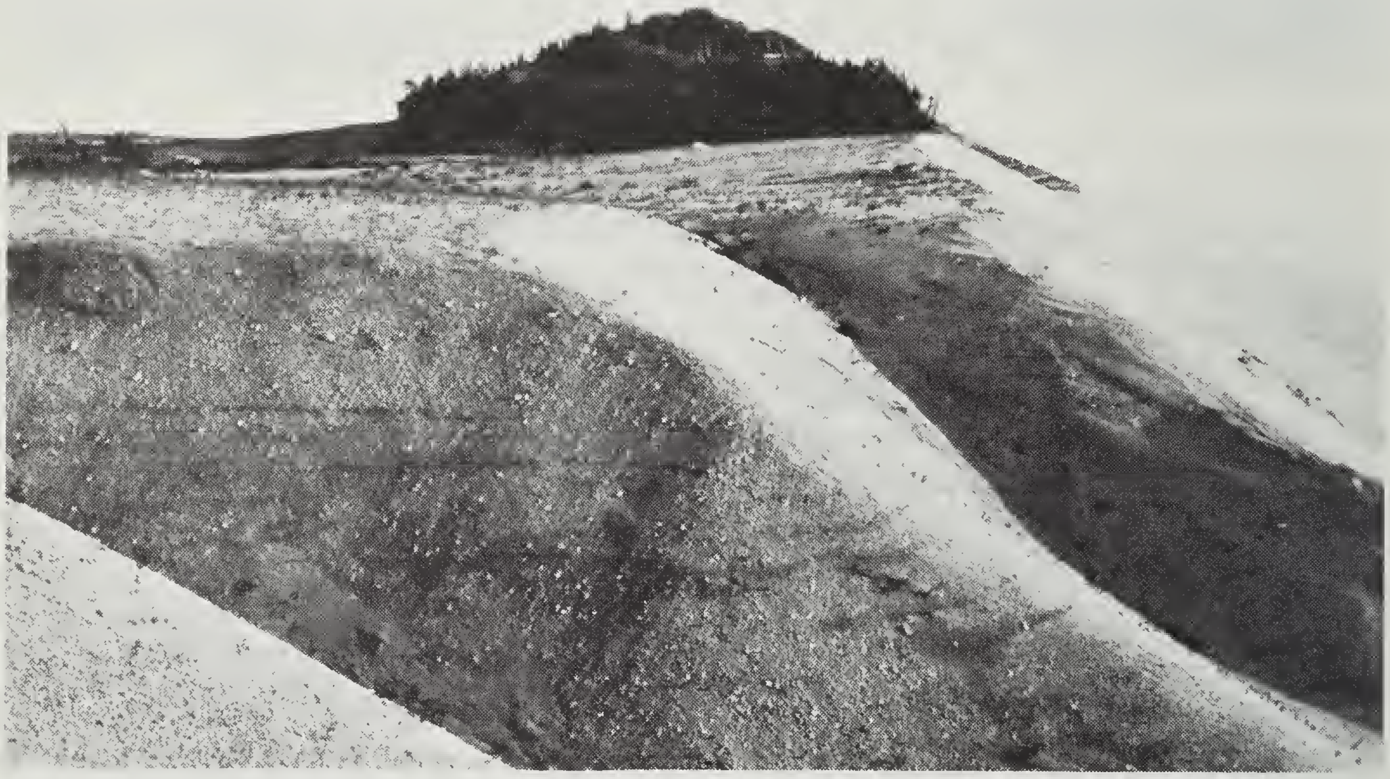


Fig. 6 (top). Looking west to Sleeping Bear dune. July 24, 1948. Photo by Grace Blanchard (from Gates, 1950).

Fig. 7 (middle). Same aspect as Fig. 6. Early July, 1956.

Fig. 8 (bottom). Same aspect as Fig. 6. August 12, 1961. Note disappearance of clump of cottonwoods from depositional area on lee side. Note also new paths up the southeast and north-northeast slopes.

orchard level below. An old ash, *Fraxinus americana,* which stood at the edge of the sand front in the early 1950's was by 1956 buried up to the midpoint of its trunk. At present, only leafy branches stick out from the moving sand. Where the sand movement is held in check by plants and where the tourists travel on diagonal paths up the slope, the vegetation is largely of *Equisetum arvense, Lathyrus japonicus, Asclepias syriaca,* and occasional *Ammophila.* Where little sand tumbles down to cover the plants, *Calamovilfa, Vitis,* and *Fraxinus* occur also.



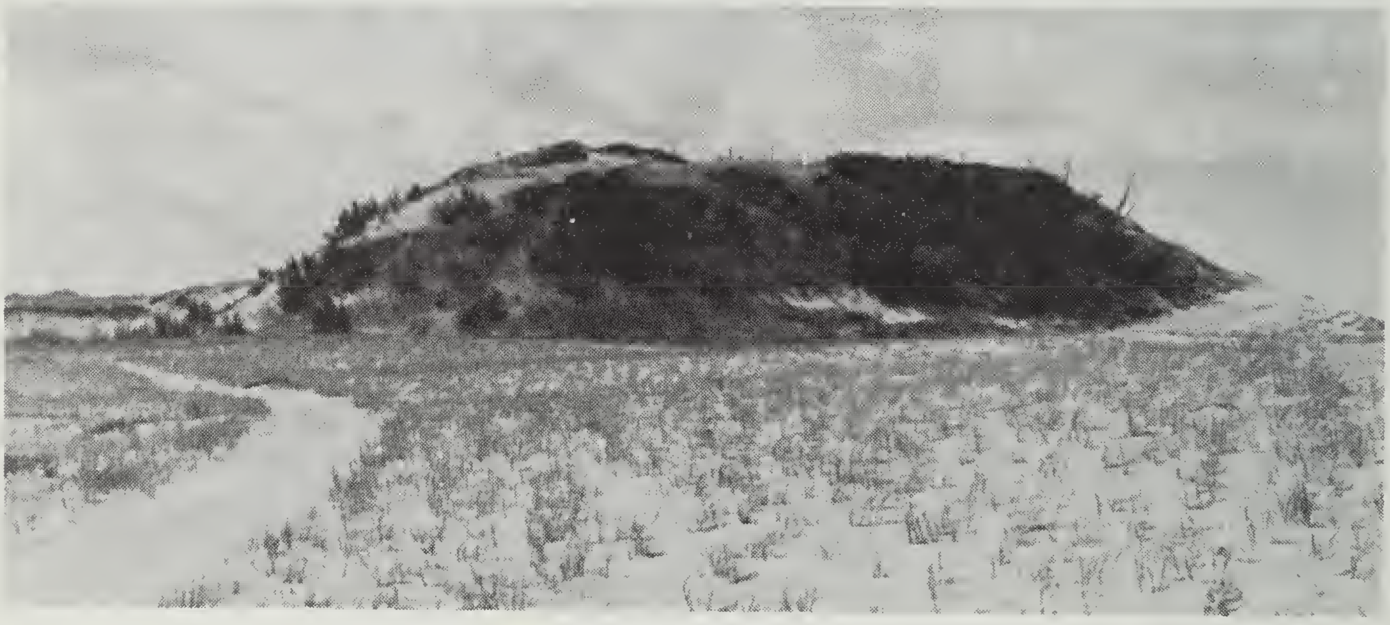


Fig. 9 (above). Looking south to Sleeping Bear dune perched on morainal plateau overlooking Lake Michigan. From a commercial postcard, undated but purchased about 1915 (from Gates, 1950). Note the forest extending to the edge of the bluff. Compare with Fig. 10, taken farther inland and closer.

Fig. 10 (below). Similar aspect to Fig. 9. August 12, 1961.

The zones of most barren sand often permit scattered annuals or biennials to "strut their hour upon the stage." *Cakile edentula, Corispermum hyssopifolium, Artemisia caudata* make their home here in this barren desert. *Arabis lyrata* appears early in the season but is gone by midsummer. *Ammophila* often encroaches upon this barren sand by means of rhizomes from nearby stabilized slopes.

Dune crests that have been stabilized for some years have *Populus deltoides* as their hallmark. *Shepherdia canadensis, Prunus pumila,* and *Elymus canadensis* inhabit these crests along with the *Populus*. The *Populus* trees, whose seeds are notably short-lived, must become stabilized in moist lows or during seasons fortuitously wet after seed set. Once established, they can keep pace with depositing sand and grow up with the dunes. (Near Saugatuck, Michigan, when an ecology class visited the dunes during excavation for a parking area a few years ago, workmen informed us that even as they leveled the sand 20 feet below the dune crest, they still cut off cottonwood trunks.)

In the stabilized lows and adjacent leeward slopes, vegetation cover is almost 100 per cent, but is restricted to low, trailing shrubs with herbs growing among the creeping branches. *Arctostaphylos uva-ursi* and *Prunus pumila* are the shrubby components, with *Campanula rotundifolia, Zigadenus glaucus, Anemone multifida, Solidago racemosa, Cirsium pitcheri,* and *Melilotus alba* intermixed.

The vast stretches of the moraine are not really a beach, but are comprised of rolling low mounds of sand and gravel, with thin veneer of sand. Dune vegetation and old field weeds prevail with frequent clones of cottonwood. This is the vegetation type which surrounds the Bear at the edge of the bluffs. *Arabis, Silene cucubalus, Cirsium pitcheri, Lithospermum croceum, Zigadenus glaucus, Orobanche fasciculata* and its host *Artemisia, Salix candida, Solidago, Poa pratensis, Œnothera parviflora,* and *Prunus pumila* are scattered irregularly.

SUMMARY

We have attempted to determine by engineering survey methods the height of the Sleeping Bear Sand Dune in 1961. The highest point is 40.14 meters above the plateau. The location of the cliff's edge (15.75 meters from the C. and G. S. marker) and the height of the sand slope (40.7 meters) that is a tourist attraction were also measured. These data suggest that cliff erosion is accelerating, as is erosion of the Bear. We urge that interested persons attempt comparative measurements at least every decade to determine the erosion of these famous cliffs and dune, and a survey of the vegetational changes associated with the progressive erosion.

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U. S. Dept. Interior. 1961. A Proposed Sleeping Bear National Seashore. Natural History Report. National Park Service, Washington. 45 pp.

Waterman, Warren G. 1927. Ecology of Glen Lake and Sleeping Bear region. Pap. Mich. Acad. 6: 351-376.

TABLE 1. Comparative Height of the Dune and Plateau from 1906 to 1961.

	altitude above sea level		height above Lake Michigan (580.0 feet; 176.8 meters)		height above plateau		source*
	feet	meters	feet	meters	feet	meters	
The Bear in 1906			490	149.4	234.0	71.33	A
in 1935					159.0	48.48	B
in 1936					143.0	43.6	C
in 1937					130.0	39.62	B
in 1939					149.0	45.4	C
in 1940					141.0	43.0	C
in 1941					138.0	42.1	C
in 1948					138.0	42.1	C
in 1949					110.0	33.53	B
in 1950					125.0	38.1	C
in 1951					120.0	36.6	C
in 1952					109.0	33.2	C
in 1953					117.0	35.7	C
in 1961	1044.6	318.5	465	141.7	131.6	40.14	D
Plateau (early)	958.0	292.1	378	115.2	-	-	B
in 1961	913.0	278.3	333	101.2	-	-	D

*Sources:

A = Army Corps of Engineers

B = Frank C. Gates (1950)

C = Frank C. Gates, University of Michigan Biological Station ecology class field notes

D = Gillis & Bakeman

MICHIGAN PLANTS IN PRINT

Guide to Literature on the Michigan Flora

3. LOCAL LISTS

The publications listed here do not have keys or descriptions, as did those in the bibliography of guides and manuals in our September 1962 issue. The present bibliography includes papers which purport to give a complete, or at least reasonaly extensive, list of the vascular plants of a particular region of the state (e.g., county, island, or other area; in the case of Beal, the entire state). If two publications cover the same area, usually only the more recent is listed, at least if it includes references to the older work. Papers primarily ecological in nature (e.g., lists from individual bogs, woodlots, etc.) are mostly not included—but the distinction is difficult to make.

—E. G. V.

Allabach, Lulu F. 1921. Plants collected in Les Cheneaux Islands, Michigan. Trillia (Proc. Bot. Soc. West. Pa.) 6: 33-40. [Brief introduction and a list of plants "collected in flower or fruit during July and August, 1920" in the vicinity (mainland and islands) of Cedarville, Mackinac Co.]

Allmendinger, E. C. 1876. Flora of Ann Arbor and vicinity. Proc. Ann Arbor Sci. Assoc. 85-116. [Of interest because the list is limited to a radius of 4 miles of what then was Ann Arbor; from a county standpoint, superseded by later work (see under Walpole, below).]

Beal, W. J. 1905. Michigan flora. Rep. Mich. Acad. (for 1903) 5: 1-147. "1904" [An annotated list replacing earlier ones for the state, but now very much out of date. Additions were published by Beal in Rep. Mich. Acad. 10: 85-89 (1908) and other additions have been included in numerous papers by Farwell, Hanes, and many others. But Beal's list remains the most recent attempt to inventory all the vascular plants of the state.]

Billington, Cecil. 1925. The flowering plants and ferns of Warren Woods, Berrien County, Michigan. Pap. Mich. Acad. 4: 81-110. [An annotated list for one of Michigan's finest tracts of virgin forest.]

Bingham, Marjorie T. 1945. The Flora of Oakland County, Michigan. Cranbrook Inst. Sci. (Bull. 22). 155 pp. [The annotated list (pp. 84-155), but not the extensive illustrated ecological introduction, superseded by Hall & Thompson.]

Brown, Clair A. [1937]. Ferns and Flowering Plants of Isle Royale, Michigan. U. S. Dept. Interior, National Park Service. 90 pp. [Introduction and annotated list which includes some univerified records and references to previous work, including the list by W. S. Cooper in Rep. Mich. Acad. 16: 109-131 ("1914" [1916]).]

Cole, Emma J. 1901. Grand Rapids Flora. A. Van Dort, Grand Rapids. 170 pp. [An unusually fine catalog, with many localities cited, useful in spite of its age. The area covered is 12-1/4 townships in Kent Co. and 4 townships in adjacent Ottawa Co. and one must often consult the map in order to place a report in the correct county.]

Dachnowski, Alfred. 1908. Flora of the Marquette Quandrangle. Rep. Mich. Acad. 9: 88-103. [Includes a list with localities noted in a limited area of Marquette Co.]

Daniels, Francis Potter. 1904. The flora of the vicinity of Manistee, Mich. Rep. Mich. Acad. 4: 125-144. [The listing of species is by habitat rather than taxonomic sequence; 750 observed in Manistee Co. in 1900 are included.]

Daniels, Francis Potter. 1904. Ecology of the flora of Sturgis, Mich., and vicinity. Rep. Mich. Acad. 4: 145-159. [Lists (by habitat) 670 species noted 1898-1899 in southeastern St. Joseph Co.]

Darlington, H. T. 1921. Contributions to the flora of Gogebic County, Michigan. Part I. Rep. Mich. Acad. 22: 147-176. Part II. Pap. Mich. Acad. 1: 74-82. 1923. [Part II, which is in the nature of a supplement, brings to over 600 the species included in an annotated list.]

Darlington, Henry Townsend. 1937. Vegetation of the Porcupine Mountains, northern Michigan. Part II. Floristics. Pap. Mich. Acad. 22: 33-68. [Pertains chiefly to Ontonagon Co., although the mouth of Little Carp River, cited as one of the localities explored, is in Gogebic Co. This annotated list is based on collections in 1922 and 1923.]

Dodge, C. K. 1900. Flora of St. Clair County, Michigan, and the western part of Lambton County, Ontario. Ann. Rep. State Hort. Soc. Mich. 29: 231-314. [A thorough and extensively annotated list.]

Dodge, C. K. 1911. Catalog of plants. pp. 65-120 in A Biological Survey of the Sand Dune Region on the South Shore of Saginaw Bay, Michigan, by Alexander G. Ruthven. Mich. Geol. & Biol. Surv. Publ. 4 (Biol. Ser. 2). [Introduction and annotated list for the shore region of Huron Co., including some references to the Charity and other islands (see next item). Supersedes an earlier list by C. A. Davis: Botanical Notes, pp. 234-245 in Geological Report on Huron County Michigan, by Alfred C. Lane; Geol. Surv. Mich. Vol. 7, Part II (1900). Some additions published by E. G. Voss in Asa Gray Bull. N. S. 2: 17-24 (1953).]

Dodge, C. K. 1911. Results of the Mershon Expedition to the Charity Islands, Lake Huron. Plants. Rep. Mich. Acad. 13: 173-190. [Brief introduction and annotated list of 372 species from these islands in Saginaw Bay.]

Dodge, C. K. 1914. The flowering plants, ferns and their allies of Mackinac Island. Rep. Mich. Acad. 15: 218-237 + 2 pp. of addenda. Republished by Edwin O. Wood in Historic Mackinac, Vol. 2, pp. 641-678. 1918. [Annotated list of over 400 species from this island in Lake Huron, Mackinac Co. A list of additions is given by J. E. Potzger in Am. Midl. Nat. 25: 303 (1941).]

Dodge, Charles Keene. 1918. Observations on the flowering plants, ferns and fern allies growing wild in Marquette County, Michigan, in 1916 and 1917, especially in the vicinity of the Huron Mountain Club. (Contributions to the Botany of Michigan, II) Univ. Mich. Mus. Zool. Misc. Publ. 5. 44 pp. [Annotated list completed by Dodge before his death; no introduction, but a folded map of Huron Mountain area.]

Dodge, C. K. 1921. Observations on the flowering plants, ferns, and fern allies on and near the shore of Lake Huron from Linwood Park near Bay City, Bay County, to Mackinaw City, Cheboygan County, including the vicinity of St. Ignace, Mackinac and Bois Blanc Islands, Mackinac County, Michigan. pp. 15-74 in Miscellaneous Papers on the Botany of Michigan, Mich. Geol. & Biol. Surv. Publ. 31 (Biol. Ser. 6). [Annotated list, often with specific county records but also often without specific records. It should be noted that, like most of Dodge's published lists, a great number of the records are not backed up with specimens in his herbarium, which was left to the University of Michigan.]

Dodge, C. K. 1921. Observations on the flowering plants, ferns and fern allies growing wild in Schoolcraft County and vicinity in the Upper Peninsula of Michigan in 1915. *Ibid.*, pp. 75-123. [The ''vicinity'' includes a number of records from Alger Co., plus several from other counties in the eastern Upper and northern Lower Peninsulas; when no locality is cited, it is thus not always clear whether a record is to be attributed to Schoolcraft County.]

Dodge, C. K. 1921. Observations on the wild plants at Whitefish Point and Vermilion, near the south shore of Lake Superior, and other parts of Chippewa

County, Michigan, in 1914. *Ibid.*, pp. 125-164. [Another annotated list. Additions have been published by Frederick J. Hermann in Pap. Mich. Acad. 22: 85-89 (1937).]

Dodge, C. K. 1921. Observations on the flowering plants, ferns and fern allies growing without cultivation in Tuscola County, Michigan. *Ibid.*, pp. 165-222. [An annotated list which supersedes the one included in an earlier report by Charles A. Davis: The native vegetation of Tuscola County. Notes on the factors affecting plant distribution. Chapter 8, pp. 290-346, in Davis' Report on the Geology of Tuscola County, Ann. Rep. Geol. Surv. for 1908. 1909.]

Farwell, O. A. 1902. A catalogue of the flora of Detroit. Rep. Mich. Acad. (for 1900) 2: 31-68. ''1901'' [Annotated list from an area now less well suited for botanizing! Additions and corrections published by Farwell in Rep. Mich. Acad. 6: 209-214. 1905.]

Farwell, Oliver A. 1914. Contributions to the botany of Michigan. No. 9. The flora of Parkedale Farm, with special reference to Stony Creek valley, Rep. Mich. Acad. 15: 150-192. [Introduction and annotated list for area in eastern Oakland County. It should be noted that Farwell specimens from ''Stony Creek'' may, however, be from a Stony Creek in Monroe Co., where he also collected. Farwell published numerous other reports on various years' collecting and interesting species.]

Gates, F. C., & J. H. Ehlers. 1925. An annotated list of the higher plants of the region of Douglas Lake, Michigan. Pap. Mich. Acad. 4: 183-284. [Annotated list for Emmet and Cheboygan counties, superseding one by Gates in Rep. Mich. Acad. 14: 83-103. Additions published by Gates & Ehlers in Pap. Mich. Acad. 8: 111-120 (1928); 13: 67-88 (1931); and 32: 27-46 (1948). Deletions published by E. G. Voss in Jour. Sci. Labs. Denison Univ. 44: 48-70 (1956) and additions in Pap. Mich. Acad. 42: 3-34 (1957). A duplicated checklist for the two-county region by Voss (25 pp., 1954 + 2. pp. supplement, 1956) re-issued in pocket checklist format by W. S. Benninghoff in 1961.]

Hall, Marion Trufant, & Paul W. Thompson. 1959. An Annotated List of the Plants of Oakland County, Michigan. Cranbrook Inst. Sci. (Bull. 39). 93 pp. [A more conservative list than that in Bingham (see above), based on specimens in the Cranbrook herbarium.]

Hanes, Clarence R., & Florence N. Hanes. 1947. Flora of Kalamazoo County, Michigan. Vascular Plants. [Publ. by authors,] Schoolcraft. 295 pp. This book is the finest local flora of its type for any region in the Upper Great Lakes area, based on extensive personal experience of the authors, identifications checked by specialists, and with copious geographic and ecological annotations. Additions published by Hanes in Pap. Mich. Acad. 34: 9-12 (1950) and by Jack C. Elliott in Am. Midl. Nat. 63: 246-247 (1960).]

Hebert, P. E. 1934. Ferns and flowering plants of Berrien County, Michigan. Am. Midl. Nat. 15: 323-342. [Unannotated list.]

McLouth, C. D. 1899. A list of plants known to grow without cultivation in Muskegon Co., Mich., and supposed not to have been introduced by human intention. [28] pp. [A mimeographed checklist dated April 1899, of which I have seen but a single copy, which is in the herbarium at Michigan State University.]

Pammel, L. H., & R. I. Cratty. 1924. Some notes on plants of Whitehall, Michigan. Proc. Iowa Acad. 30: 279-285. [Brief introduction and unannotated list for region in Muskegon Co. Names of many of the species after the Leguminosae are marked with an unexplained asterisk.]

Potzger, J. E. 1944. The vegetation of Round Island (Straits of Mackinac), Michigan. Butler Univ. Bot. Stud. 6: 116-122. [Includes a list of 84 species collected in two days in August during 1935 and 1936.]

Sutton, John M. 1918. Flora of the Detroit Zoological Tract. Rep. Mich. Acad. 19: 263-271. [Unannotated list from vicinity of Royal Oak in Oak-

land County. Attribution of Sutton's specimens from the "Detroit Zoo" to Wayne Co., as is often done, is in error, as the zoo is two miles beyond Wayne Co.]

Voss, Edward G. 1950. Observations on the Michigan flora, III. The flora of Green Island (Mackinac County). Ohio Jour. Sci. 50: 182-190. [Introduction and annotated list of 138 species from tiny island in the Straits of Mackinac.]

Walpole, Branson A. 1924. Flora of Washtenaw County Michigan. Ypsilanti, Dept. Nat. Sci., M. S. N. C. 80 pp. [Introduction and annotated list. Additions have been published by F. J. Hermann in Pap. Mich. Acad. 21: 81-87 (1936); 22: 91-94 (1937); 24: 17-23 (1939). A cumulative revised checklist prepared in 1943 by B. Robertson Clarke was mimeographed (28 pp.); reissued with further revisions in pocket checklist format by W. S. Benninghoff in 1962.]

4. INFORMATION ABOUT THE FLORA OF MICHIGAN

A few selected references are listed here as aids in learning what is already known about the flora of the state: bibliographies, data on herbaria, history, etc. In addition, see the bibliographies in the three previous parts of "Guide to Literature on the Michigan Flora" in THE MICHIGAN BOTANIST as well as the continuing list of new literature.

(Beal, W. J.) 1899. What the Agricultural College has done toward a state botanical survey. Ann. Rep. Sec. State Board Agric. Mich. 37: 100-104. [Includes many historical data on early collections and collectors.]

Blake, S. F., & Alice C. Atwood. 1942. Geographical Guide to Floras of the World. Part I. U.S. Dept. Agric. Misc. Publ. 401. 336 pp. [Michigan titles in this annotated list of floristic works are on pp. 189-192 (not including a Kellogg item attributed to Cheboygan Co. which actually pertains to Minnesota); the list is in large part superseded by the one above.]

Darlington, H. T. 1945. Taxonomic and Ecological Work on the Higher Plants of Michigan. Mich. Agric. Exp. Sta. Tech. Bull. 201. 59 pp. [Includes a very brief history of botanical work in the state, a general survey of the major habitats and plant families, and a very useful bibliography.]

Hagenah, Dale J. 1952. The new Michigan flora, an opportunity for local botanists. Asa Gray Bull. N. S. 1: 353-357. [Includes data on counties considered the best known and the least known botanically on the basis of Pteridophyte and *Carex* records.]

Lanjouw, J., & F. A. Stafleu. 1959. Index Herbariorum Part I The Herbaria of the World. 4th ed. Regnum Vegetabile Vol. 15. 249 pp. [Michigan herbaria, with the internationally accepted abbreviated symbol for each, are listed on page 230, and are individually entered in the main directory, which is alphabetical by cities. A new edition is in preparation.]

McVaugh, Rogers, Stanley A. Cain, & Dale J. Hagenah. 1953. Farwelliana: An Account of the Life and Botanical Work of Oliver Atkins Farwell, 1867-1944. Cranbrook Inst. Sci. (Bull. 34). 101 pp. [Includes a biographical sketch and description of the methods of one of the state's most active and well-known botanists, with an annotated list of the more than 300 taxa proposed as new by Farwell and a bibliography of over 150 titles. Most of Farwell's publications cite Michigan specimens, and a card-file index to these citations, by species, originally prepared by F. J. Hermann, has been completed and is in the University of Michigan Herbarium. Indexes to Farwell's collections, and his field notes, are at the Cranbrook Institute of Science, where his herbarium is.]

Rogers, Claude Marvin. 1952. The comparative representation of Michigan plants in certain herbaria. Asa Gray Bull. N. S. 1: 349-351. [Includes figures on the representation of specimens, county records, and species of the order Geraniales (as defined by Fernald) in herbaria within and outside the state. No new taxa were added by consulting out-of-state herbaria, and an average of less than 1.5 additional county record per species.]

Voss, Edward G. 1956. A history of floristics in the Douglas Lake region (Emmet and Cheboygan counties), Michigan, with an account of rejected records. Jour. Sci. Labs. Denison Univ. 44: 16-75. [The lengthiest historical treatment of collecting in any part of the state, with extensive bibliography and biographical notes.]

New Literature Relating to Michigan Botany

The aim of this section is to cover all significant literature relating to Michigan botany published since the beginning of 1960, without attempting much coverage of related fields such as agriculture, conservation, and forestry. When the subject matter or relation to Michigan is not clear from the title, annotations are added in brackets.

A. MAPS, SOILS, GEOGRAPHY, GEOLOGY

United States Series of Topographic Maps, Scale 1:250,000. This series has just been completed for Michigan (except for two very small areas). The scale is about one-fourth inch to a mile. The maps show a contour interval of 50 feet, sometimes supplemented with 25-foot contours; they have a green overprint (unless request is made for maps without it) showing woodland areas, and they show as many cultural features as practical for their scale. Altogether, they make a fine atlas of the state. Each sheet covers an area of one degree of latitude and two degrees of longitude; this means that some are largely of water areas in Lake Michigan. The "Cheboygan" sheet is a very convenient unit for the northern Lower Peninsula, covering the area from Hammond Bay to Torch Lake and the Beaver Islands, and from Gaylord to Brevort Lake in the southern Upper Peninsula; apart from a few errors (like mislocation of the Mackinac Bridge) it should be extremely useful to workers at the University of Michigan Biological Station.

The sheets are available from the U. S. Geological Survey, Washington, D. C., at $ .50 each (20% discount on orders for $10.00 or more). The list below includes each sheet by name, date of survey (not date of publication, which is usually 3-5 years later), sheet number, and limiting parallels and meridians, respectively. Several of these sheets include considerable areas of neighboring states and Ontario, but all which show a part of Michigan are listed.

Hancock (1958), NL 16-1 & 2; 47°-48°; 87°30' - 90°
Ashland (1953), NL 15-6; 46-47; 90-92
Iron River (1958), NL 16-4; 46-47; 88-90
Marquette (1958), NL 16-5; 46-47; 86-88
Sault Ste. Marie (1954), NL 16-6; 46-47; 84-86
Iron Mountain (1954), NL 16-7; 45-46; 88-90
Escanaba (1954), NL 16-8; 45-46; 86-88
Cheboygan (1955), NL 16-9; 45-46; 84-86
Alpena (1954), NL 17-7; 45-46; 82-84
Manitowoc (1954), NL 16-11; 44-45; 86-88
Traverse City (1954), NL 16-2; 44-45; 84-86
Tawas City (1954), NL 17-10; 44-45; 82-84
Milwaukee (1954), NK 16-2; 43-44; 86-88

Midland (1954), NK 16-3; 43-44; 84-86
Flint (1954), NK 17-1; 43-44; 82-84
Racine (1958), NK 16-5; 42-43; 86-88
Grand Rapids (1958), NK 16-6; 42-43; 84-86
Detroit (1944), NK 17-4; 42-43; 82-84
Chicago (1953), NK 16-8; 41-42; 86-88
Ft. Wayne (1953), NK 16-9; 41-42; 84-86
Toledo (2nd ed., 1956), NK 17-7; 41-42; 82-84

C. JOURNAL ARTICLES

Arnold, Chester A. 1961. Re-examination of Triletes superbus, T. rotatus, and T. mamillarius of Bartlett. Brittonia 13: 245-252. [A restudy of fossil spores from coal pebbles in glacial drift near Ann Arbor.]

Bailey, Virginia Long. 1962. Revision of the genus Ptelea (Rutaceae). Brittonia 14: 1-45. [Includes map and citations of specimens showing Michigan occurrence of *P. trifoliata* subsp. *trifoliata* var. *trifoliata*.]

Beal, Ernest O. 1960. Sparganium (Sparganiaceae) in the southeastern United States. Brittonia 12: 176-181. [Distribution maps for *S. americanum* and *S. chlorocarpum* include Michigan.]

Chambers, Henrietta L. 1961. Chromosome numbers and breeding systems in Pycnanthemum (Labiatae). Brittonia 13: 116-128. [Includes reference to a herbarium collection of *P. virginianum* from Michigan.]

Cummins, George B., & H. C. Greene. 1961. The rust fungi of Muhlenbergia, Sporobolus, and related genera. Brittonia 13: 271-285. [Michigan records cited for *Puccinia amphigena* on *Smilax* and *Calamovilfa; Uromyces minimus* on *Muhlenbergia*.]

Getz, Lowell L. 1960. Standing crop of herbaceous vegetation in southern Michigan. Ecology 41: 393-395. [Observations from four habitats in Washtenaw Co.]

Getz, Lowell L. 1961. Temperatures in different vegetation types in southern Michigan. Jack-Pine Warbler 39: 132-147. [Data from six vegetation types in Washtenaw Co.]

Griffin, Dana G., III. 1961. Pohlia bulbifera — a new record for Michigan. Bryologist 64: 383. [This moss reported from Whitefish Point, Chippewa Co. (erroneously stated to be in Luce Co.).]

Gysel, Leslie W. 1962. Vegetation and animal use of a power line right-of-way in southern Michigan. Quart. Bull. Mich. Agr. Exp. Sta. 44: 697-713. [Includes data on vegetation and effects of herbicides for area in Kalamazoo Co.]

Hesler, L. R., & Alexander H. Smith. 1960. Studies on Lactarius—I The North American species of sect. Lactarius. Brittonia 12: 119-139. [Michigan collections cited for several species, including the types of two new ones.]

Hesler, L. R., & Alexander H. Smith. 1960. Studies on Lactarius — II The North American species of sections Scrobiculus, Crocei, Theiogali and Vellus. Brittonia 12: 306-350. [Several species cited from Michigan, including the types of eight new taxa.]

Jones, K. L. 1961. An analysis of Streptomycete populations in soils. Pap. Mich. Acad. 46: 161-181. [Four of the 16 soils studied were from Ann Arbor, and four from Cheboygan.]

Kapp, Ronald O., & William A. Kneller. 1962. A buried biotic assemblage from an old Saline River terrace at Milan, Michigan. Pap. Mich. Acad. 47: 135-145. [Includes pollen profile and interpretation from early Nipissing time, ca. 4000 years ago.]

Kesling, Robert V., & Alan Graham. 1962. *Ischadites* is a Dasycladacean alga. Journ. Paleont. 36: 943-952. [Study based on fossil from Delta Co.)

Kilburn, Paul D. 1960. Effect of settlement on the vegetation of the University

of Michigan Biological Station. Pap. Mich. Acad. 45: 77-81. [Some early data on logging and fires in Cheboygan Co.]

Knight, Allen, & Robert C. Ball. 1962. Some estimates of primary production rates in Michigan ponds. Pap. Mich. Acad. 47: 219-233. [Data on production of organic matter by microscopic and macroscopic plants in ponds in Missaukee Co.]

Kral, Robert. 1960. A revision of Asimina and Deeringothamnus (Annonaceae). Brittonia 12: 233-278. [*A. triloba* is cited from Washtenaw Co.]

Long, Robert W. 1960. Biosystematics of two perennial species of Helianthus (Compositae). I. Crossing relationships and transplant studies. Am. Jour. Bot. 47: 729-735. [Material of *H. giganteus* and *H. divaricatus* came from Michigan, but Jackson and Lansing are attributed to Hillsdale and Shiawassee counties respectively, so it is not clear whether the specimens came from the city or county named.]

Long, Robert W. 1961. Biosystematics of two perennial species of Helianthus (Compositae), II. Natural populations and taxonomy. Brittonia 13: 129-141. [Some materials used in the investigation were collected in Michigan, with the same confusion of localities as in the preceding. Distribution maps of *H. giganteus*, *H. grosseserratus*, and their hybrid, *H.* × *luxurians*, include Michigan counties.]

Lowe, Josiah L. 1961. Southern and tropical polypores, II. Pap. Mich. Acad. 46: 205-207. [*Poria salmonicolor* said to be known from Michigan.]

Norstog, Knut. 1960. The occurrence and distribution of *Hierochloe odorata* in Ohio. Ohio Jour. Sci. 60: 358-365. [Includes a few comparative references to Michigan observations on fertility and polyembryony.]

Review

MANUAL OF VASCULAR PLANTS OF NORTHEASTERN UNITED STATES AND ADJACENT CANADA. By Henry A. Gleason and Arthur Cronquist. Van Nostrand, Princeton, N.J. 1963. li + 810 pp. $11.75.

The purpose of a manual such as this—or Gray's Manual, with the 8th edition of which this must inevitably be compared—is primarily, if not entirely, to facilitate identification of plants. Hence, it is presumptuous to attempt a review before hard use has demonstrated the practical effectiveness of the volume. My prediction is that this new manual will prove to be excellent for identification.

Cronquist points out in the preface that this single volume is based on the 3-volume New Britton and Brown Illustrated Flora by Gleason and collaborators (1952), and that insofar as the result resembles the first printing of the larger treatise it is the work of Gleason while "insofar as it differs it is the work of Cronquist." Thus disposing succinctly of the responsibilities of joint authorship, the preface acknowledges the collaborators for the Illustrated Flora, and states that Gaspe and Missouri south of the Missouri River have been omitted from the area covered. There follows a very incomplete list of abbreviations employed, a glossary, the keys and manual proper, and an index.

Thus, the manual requires a certain minimum of previous knowledge about botany, or a concurrent text or teacher. For there is no introduction whatsoever to the nature of classification, scientific names and categories, author citations (and their abbreviations), keys, synonymy and nomenclature, or to the preparation of specimens.

This manual has a smaller page size than Gray's Manual and is thinner, although printed on heavier paper. It also sells for distinctly less. Compression of the Illustrated Flora into handy size is accomplished not only by omitting all introduction and illustrations, but also by the use of readable yet small print (especially in the keys) and a generally condensed style. ''Pet,'' ''cal,'' ''lvs,'' and similar abbreviations for plant parts are used throughout. [''Io.'' is presumably an abbreviation for Iowa, not Idaho, although it is hardly less ambiguous than ''Ia.''] Printing is evidently by offset from typeset galleys, hopefully allowing for the easy correction of a high incidence of typographical errors.

The keys are basically those of the Illustrated Flora, but now seem all to be strictly dichotomous except for the General Keys (to families, etc.), which nevertheless will prove much more workable for identification (which I believe is the sole function of a true key) than the impossible family key in Gray's Manual. The only *major* difference in taxonomic treatment from the Illustrated Flora is in *Crataegus*, where there is an admitted ''drastic condensation'' to 21 species. Neither these nor the similar units in *Rubus* are even called ''collective species'' now.

There are, of course, innumerable smaller changes in taxonomy and nomenclature from the Illustrated Flora, many of them based on the intervening literature. A very welcome improvement is the effort, when indicating names in past use, to distinguish true synonyms from names which have been ''misapplied.'' A few observations, relating primarily to Michigan plants, will be made as examples, without necessarily implying that each change (or failure to change) is good (or bad):

This is the first manual to credit the new weed *Filago arvensis* to Michigan. However, in Brittonia 6 years ago *Agoseris glauca* was cited from Michigan, while the new manual still lists it only westward from Minnesota; *Knautia arvensis*, thoroughly naturalized in the Upper Peninsula, is mentioned only west to Pennsylvania; and *Bromus squarrosus* is nowhere mentioned at all. *Listera auriculata* is not attributed to Minnesota and in Michigan only to Isle Royale (misspelled here and under ''*Opolopanax*,'' p. 500, but not under *Empetrum*). The Hart's-tongue fern (*Phyllitis*) is properly mentioned for Chippewa Co., and *Antennaria rosea* is now recognized as a Michigan plant.

Anacharis is still used for *Elodea*, although the latter did not even need the nomenclatural conservation once proposed for it. *Dracocephalum* is said to have been conserved by an International Botanical Congress; this is a premature statement, as the name was approved by the General Committee July 7, 1960, and hence may be used, but it has not yet been officially acted upon by a Congress (Taxon 9: 222. 1960). Awareness of nomenclatural problems is sometimes expressed (e.g., *Bromus purgans*, *Koeleria cristata*) without adoption of unfamiliar names; in other instances (e.g., *Oxalis stricta*) the required changes are made. Many other changes are apparently based at least in part on recent work: e.g., Clausen on *Puccinellia*, Sauer on *Amaranthus*, Wood on *Drosera*, Ray on the inclusive *Lysimachia*. On the other hand, whether intentionally or not, the treatment of some genera reflects little or no influence of recent work: e.g., Russell on *Viola*, Shinners on *Lythrum*, Fisher on *Heliopsis*. *Elymus mollis* is still reported from Lakes Huron and Michigan in spite of Bowden; the name *Hemerocallis flava* is maintained in spite of several published notes; the old confusion in *Sisyrinchium* (one of the weakest spots in the Ill. Flora) still prevails.

All in all, the new manual is a conservative, reasonably modern treatment (even chromosomal conditions *are* sometimes mentioned!), with keys much better constructed in terms of simplicity and parallelism than in Gray's Manual, mention of few varieties and (?) no forms, and a convenient format. As such, it should have wide use among students and others needing to gain a knowledge of local plant *species*. It cannot replace Gray's Manual as a more complete reference source on finer points of variation, and the serious student will, in the long run, need both.

—E. G. Voss

PROGRAM NOTES

MICHIGAN BOTANICAL CLUB

March 31: State Meeting, in Ann Arbor, with Huron Valley Chapter as host. (Postponed from March 10.) The main speaker will be Professor Volney Jones, speaking on ethnobotany of North American Indians. Meeting will be in Ann Arbor High School.

June 7, 8, 9: Spring Campout, Gilbert Lodge at Twin Lakes. Details later.

Conservation Report

Stimulated! Concerned! Inspired! Challenged! These were the feelings I had when I left the Higgins Lake Conservation Training School last July. I had just spent a week participating in one of the summer sessions offered to teachers and made available through scholarships given by various local and state clubs and societies interested in conservation. (My sponsor was the Michigan Botanical Club.)

During the week at this school, we were concerned with all phases of conservation—soils, minerals, water, forests, fish, wildlife, and human resources. Lectures, expertly delivered by Conservation Department personnel and several guest lecturers, gave us a sound, thorough background for understanding and appreciating conservation problems on a state-wide basis. Several field trips were planned so that we would see directly some of the problems discussed during classtime and the conservation methods used to reclaim, rebuild, or reuse the resources.

Throughout the session, conservation was emphasized and taught not as a nature study, but rather as the wise use and management of, and the relationships among, all our natural resources. Conservation concepts, principles, and laws were meaningfully integrated and explained in every class meeting.

The principal objective of the School is to so familiarize and educate teachers concerning conservation needs and practices that they will be encouraged to take back this training to their schools and use it in their classrooms. Certainly this objective has been accomplished countless times by the scores of teachers who have attended the School and have gone back home not only to teach and tell about conservation—but also to *live* it!

It would be wonderful if all the teachers in Michigan could have and would accept the opportunity to spend a week of their time for such worthwhile gains.

—Florence Schermerhorn
Haisley School
Ann Arbor, Michigan

The date of mailing of the previous number (Vol. II, No. 1) was January 3, 1963.

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(Cover photo: Windswept southwest face of Sleeping Bear Dune. Margaret B. Feigley, July 22, 1949)

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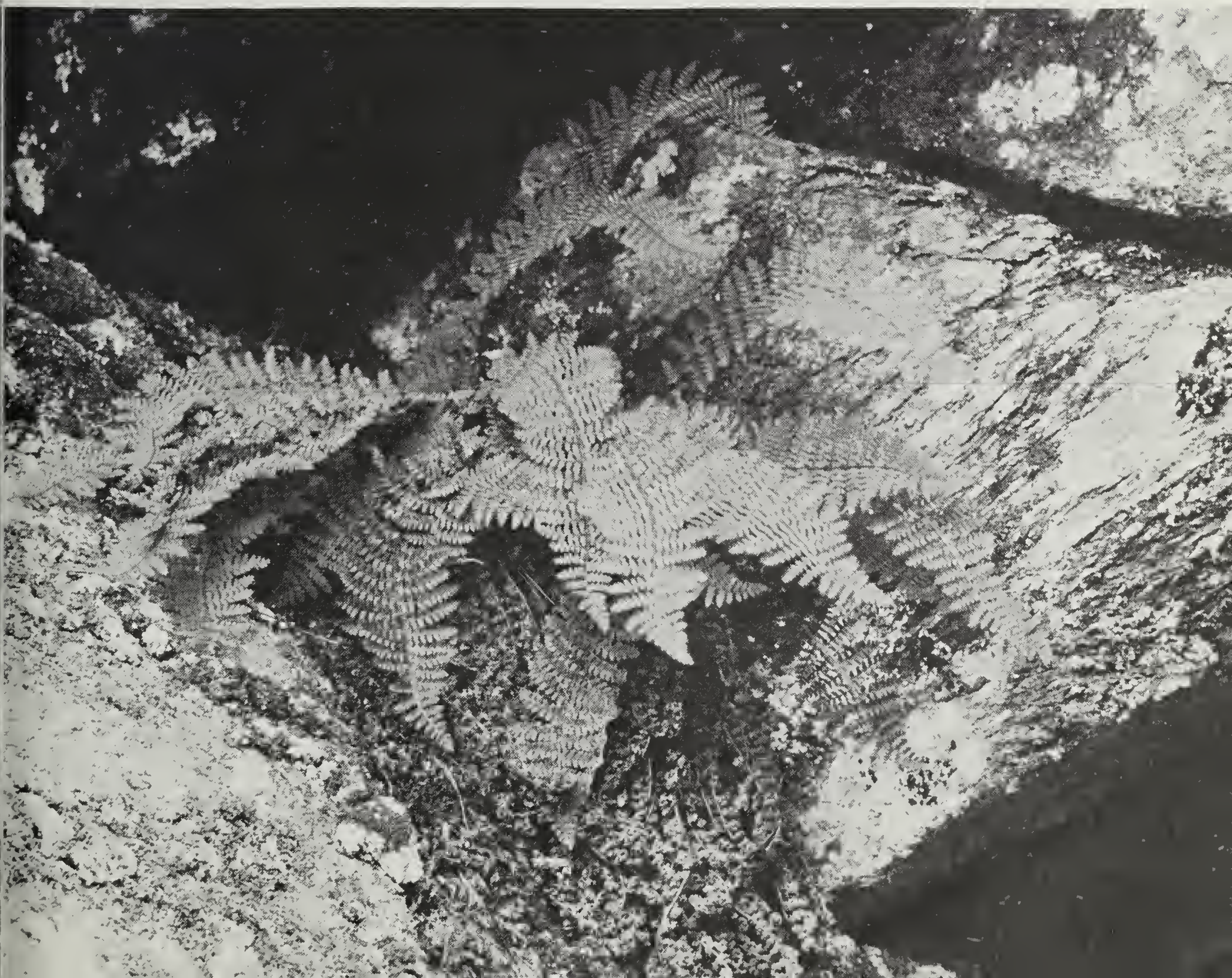
THE
MICHIGAN BOTANIST

May, 1963



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THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora and to establish suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

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THE USE OF FLORAL PIGMENT CHROMATOGRAPHY AS AN AID IN THE TAXONOMY OF *VIOLA*[1]

James E. Munson
Department of Biology, Wayne State University

The recent improvement of paper chromatography as a refined technique for the analysis of microsamples of material has greatly enhanced its possibilities as a taxonomic tool. It seemed feasible to attempt to apply this technique to the genus *Viola,* many species of which do not lend themselves to classification by standard morphological means. At the present time, Russell (1954-1958) is engaged in attempting to solve this morphological problem, but it is felt that the use of this additional tool may help gain a clearer understanding of the relationships within the genus.

With Robinson and Robinson's (1931) pioneering work surveying the anthocyanins and suggesting the genetic factors involved in the formation of the great variety of water soluble floral pigments, there was only needed a rapid method for the analysis of the individual plant substances. The efforts of Consden et al. (1944) resulted in the development of paper chromatography, which opened the door to a rapid and accurate analysis of microsamples of material.

During the past ten years, several researchers have applied this technique, having as their goal the development of a clearer understanding and a more nearly correct solution of the problems of relationship confronting the taxonomist. One of the initial studies in this area was that of Lindstedt (1951) who analyzed the polyphenols from extracts of the heartwood of 48 species of *Pinus* by chromatographic methods. From this he was able to develop a chemical classification of the pines which was in close agreement with that which resulted from morphological studies.

Buzzati-Traverso and Rechnitzer (1953) analyzed extracts of fish tissue and found differences in amino acid patterns in different species, though intraspecific patterns were constant regardless of the age or size of the fish. They further noted greater pattern similarity existing between the more closely related species. They concluded that these observations indicated the possibility of using the chromatographic method for biochemical determination of phylogenetic relationships.

Early in 1959, Thompson et al. published an extensive review of the use of partition chromatography in the plant sciences, citing 1466 references. Their compilation and coordination of data concerning the use of partition chromatography is perhaps the most important single paper on the subject.

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[1] Contribution No. 97 from the Department of Biology, Wayne State University. A portion of the publication costs of this article has been defrayed by the Department.

Later, Turner and Alston (1959), continuing the work begun by Alston and Hagen (1958) on pattern variation in different genotypes of *Impatiens balsamina,* used floral pigment chromatography by demonstrate introgressive hybridization in a hybrid swarm of *Baptisia* species. They were able to show introgression by comparing the chromatographic patterns of the two parental species with those of the hybrid swarms.

Also in 1959 Teas et al. worked out a chromatographic technique for identifying mango varieties using alcohol-acetone extracts of leaf samples. Working with 21 different varieties they were able to distinguish 7 while the remaining 14 could be placed into four groups of 2-5 varieties each. Normally the fruit of the mango is used in the classification, but since it fruits only in alternate years, part of the success of this work lies in its usefulness in the identification of the mango varieties at any time.

Stoutamire (1960) studied the relation of the floral anthocyanins to *Gaillardia* taxonomy. He concluded that the chemical differences in ray flower color closely parallel the morphological differences and that they, therefore, provide another useful tool in analyzing relationships of the species.

Riley and Bryant (1961) devised a method for determining relationships in nine species of African Iridaceae. Root tips were smeared directly on the filter paper and the spots were developed using the descending method of chromatography. The results demonstrated that greater variations occurred between genera than between species within a genus, and they concluded that this method might be a useful addition to the conventional means of studying taxonomy.

V. ADUNCA	7
V. AFFINIS	2, 4
V. CANADENSIS	4, 9-
V. CONSPERSA	4, 11
V. CUCULLATA	8, 10
V. INCOGNITA	4
V. NEPHROPHYLLA	10, 11
V. PEDATA	2, 5, 7
V. PENSYLVANICA	4
V. ROSTRATA	4
V. SAGITTATA	1, 2, 3
V. SORORIA	4, 6
V. STRIATA	4

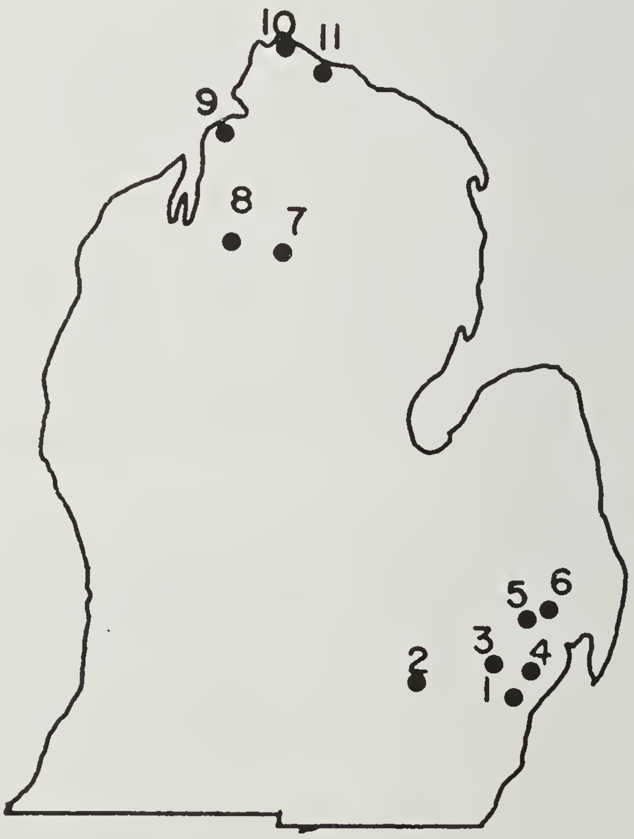

Fig. 1. Species of *Viola* collected and their location.

MATERIALS AND METHODS

In the spring of 1961, collections were made of available species of *Viola* in Michigan. The species collected and their location are indicated in Fig. 1.

At least one herbarium specimen was made from representatives of each population collected. These specimens were later used to classify the population morphologically. This was accomplished by keying the specimens in Gray's Manual of Botany (Fernald, 1950) and then checking the determination by comparing it with critically selected specimens in the herbaria of the University of Michigan and Wayne State University.

The remaining plants of each collection were sealed in a plastic freezer bag and frozen. The maximum time between collecting and freezing was 12 hours, but most material was frozen within 3-5 hours after collection. In each collection all flowers past their prime were discarded, and, where possible, fifty or more flowers were collected. Each population was given a number and each chromatogram made of a population was given a different letter suffix to identify it.

A frequently suggested extracting solvent of 1 part hydrochloric acid: 99 parts 95% ethyl alcohol was tried but discarded because of the wide and often overlapping bands that resulted on the chromatograms. The production of wide bands may be due to the partial salt formation and hydrolysis that occurs in the flavonoid substances extracted. This apparently causes absorption-diffusion differences in those substances, resulting in the wider band formation. In an attempt to solve this problem many extracting solutions, including various concentrations of hydrochloric acid and sulfuric acid in both ethyl alcohol and methyl alcohol, were tried. It was decided that a solvent of 1 part glacial acetic acid: 99 parts 95% ethyl alcohol would be used to extract the floral pigments. This was successful in narrowing the band dispersion, although, with anthocyanins, it failed to produce salts that were clearly seen under visible light. The bands were found to be quite discernable, however, when viewed under shortwave ultraviolet light with main emissions at about 3600 A^{o}. Following a thirty-minute drying period the chromatograms have maintained their stability for at least a five to six month period.

The following procedure was used. The petals were removed from twenty flowers of each population and placed in approximately thirty ml. of the acetic acid: ethyl alcohol solution. This was placed on a steam bath for five minutes and then filtered through Whatman #1 filter paper. Next, the solution was evaporated to approximately three ml. to concentrate the extract. The extracts were used the same day they were prepared. The spotting of the chromatograms was accomplished by applying 100 lambdas (0.1 ml.) of the extract as a one-half inch streak, three inches from one end of a sheet of Whatman #1 filter paper. The chromatogram was placed in a chromatocab with the lower phase of an ethyl acetate : t-butanol : water : glacial acetic acid (5:4:3:1, v/v) solution, and allowed to equilibrate approximately 12-14 hours. With this solvent all chromatograms were developed by the descending method and were run until the solvent front had travelled 30-35 cm. They were allowed to dry and were then sprayed with a 2% $AlCl_3$ (ethanolic) solution as used by the Robinsons (1931) to enhance the color of the anthocyanins. The chromatograms were duplicated at least once with each extract.

The fluorescent color of each band under ultra-violet light was recorded and the Rf (distance travelled, divided by total distance travelled by solvent front) of the leading edge was determined. The chromatograms were photographed under ultraviolet light with a Polaroid Land camera back and a bellows front allowing for extension to approximately two focal lengths. A Viking anastigmat lens made by Agfa-Ansco, set at f-7.7, with a Kodak K-2 filter attached, was used. The exposure time was approximately 40 seconds using Polaroid 3000X film. During this time the ultraviolet lamp was moved over the chromatogram to allow for an even exposure.

RESULTS

Results obtained chromatographically are subject to several possible variables which warrant some discussion. The one most difficult to control in collections of wild populations is hybridization. That it may affect chromatographic results has previously been demonstrated by Turner and Alston (1959) in their use of pigment chromatography to show evidence of introgression. The genus *Viola* contains several species, including some used in this work, which frequently hybridize. The results obtained for *V. affinis* and *V. sororia* seem to point out the effects caused by apparently hybrid populations. These results will be treated in more detail later in the discussion of those species.

A second variable over which the collector has no control in wild populations, is natural variation within a species. Alston and Hagen (1958) confirm this by their demonstration of chromatographic pattern differences occurring in the various genotypes of *Impatiens balsamina.* The magnitude of this problem has been reduced to some extent by the collection of populations of the same species from distant and diverse habitats.

A third factor commonly encountered when collecting populations of the same species from a number of habitats is the ecological variation. For example, sunlight is known to affect the quantity of the anthocyanin pigments and several species of violets are known to be deeper in floral color when growing in the shade than when growing in the sun. Although ecological variation is a factor to consider, the results obtained from this work indicate that no major differences in chromatographic patterns were due to this factor.

Petal age may also influence pigment quantity or quality. *Viola canadensis* is an unusual example of a violet which illustrates the effect of petal age since it gradually changes from a creamy-white to a pale violet as it matures. To guard against this, petals showing any noticeable signs of aging were not used for extraction purposes.

It is believed that other variables, such as chromatocab temperature, extract concentration, solvent age, extraction procedure, etc., which can be dealt with by careful laboratory technique, have been eliminated as possible causes of chromatogram variations.

The chromatographic results obtained in each of the following species are illustrated in Figs. 2 and 3.

Viola pedata L. (Bird-foot Violet)

Collections were made of this species from three widely separated locations in Michigan (2, 5, 7, Fig. 1). *Viola pedata* is a very distinct and uniform species morphologically and is not known to hybridize with any other Michigan violet. The chromatographic results obtained further indicate its uniformity throughout this range. These results were the first test of the plausibility of the chromatographic method as here applied to the taxonomy of *Viola*. If, in such a stable species as this, the chromatographic patterns obtained were not uniform, then the technique used would need revision or an entirely new approach to this problem would have to be developed. Figures 2 and 3 illustrate the pattern uniformity that was found in these three populations and thus it was deemed feasible to continue using this technique on the mor complex members of the genus.

Viola sagittata Ait. (Arrow-leaved Violet)

Viola sagittata was collected in locations 1, 2, and 3 as shown in Fig. 1. Population 22 from location 3 was unidentified when chromatographed and the first identification made of this population was by pattern comparison after all species had been chromatographed. When these patterns were examined, it was clearly evident that the unknown's pattern was very similar to those produced by known populations of *V. sagittata*. An herbarium specimen of population 22 was then studied and verified as *V. sagittata*. The success of this chromatographic identification was very encouraging.

Viola cucullata. Ait. (Marsh Violet) and *V. nephrophylla* Greene. (Northern Bog Violet)

These two species of blue violets are a great deal more difficult to classify morphologically. Plants of population 1, when first collected, were identified as *V. cucullata*. They were growing in a tamarack swamp in Kalkaska Co. (location 8, Fig. 1.). When compared with herbarium specimens, they were verified as being *V. cucullata*.

Chromatogram 10, however, was made from plants collected at the edge of a roadside stream bordering on a tamarack swamp in

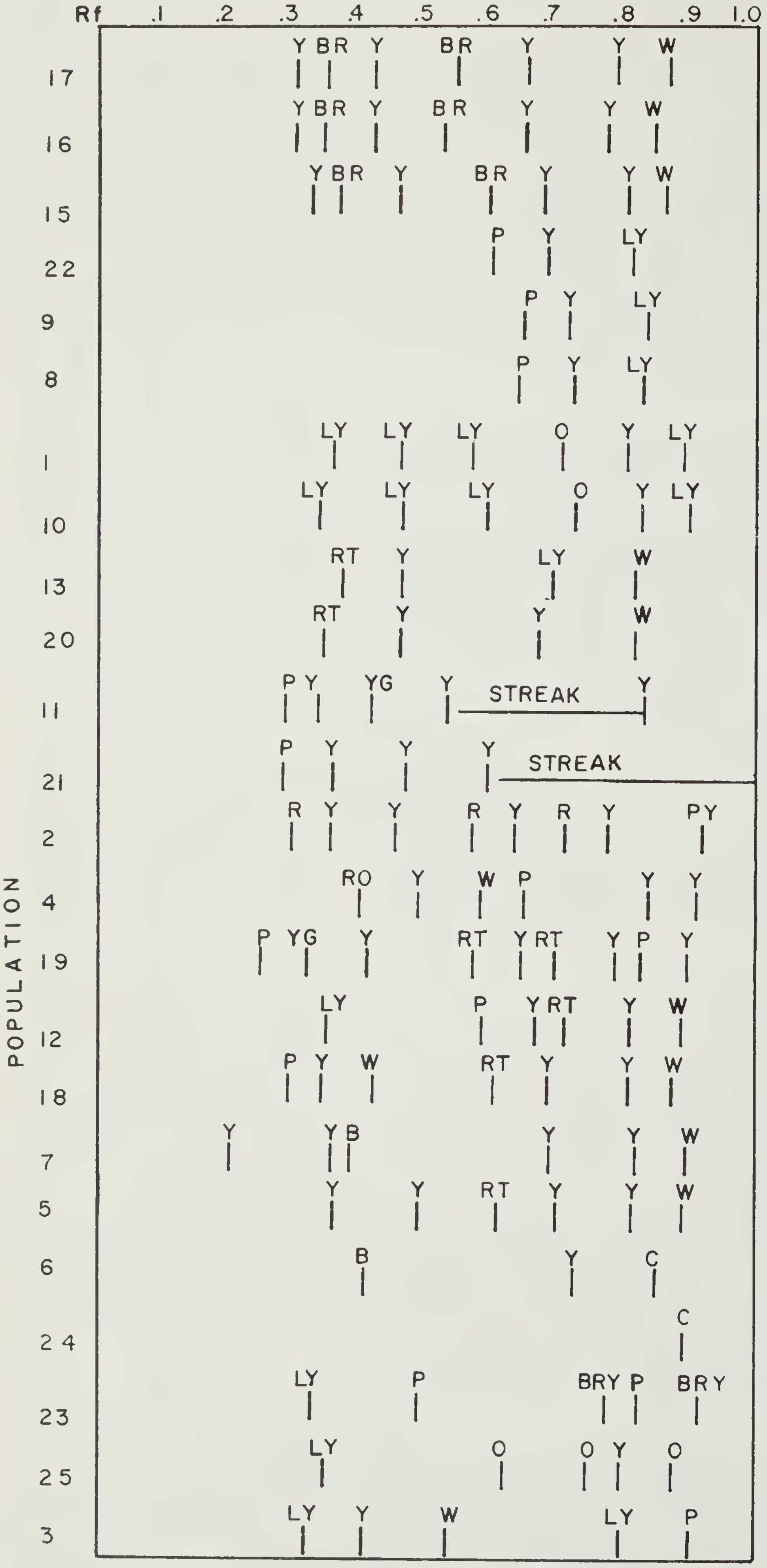

Fig. 2. Average Rf values for:

Viola pedata (17, 16, & 15)
V. sagittata (22, 8, & 9)
V. cucullata (1 & 10)
V. nephrophylla (13 & 20)
V. affinis (11, 21, & 2)
V. sororia × *V. papilionacea* (4)
V. sororia (19)
V. rostrata (12)
V. conspersa (18 & 7)
V. adunca (5)
V. canadensis (6 & 24)
V. incognita (23)
V. striata (25)
V. pensylvanica (3)

Designations of colors as seen under ultraviolet light:

Y, yellow
LY, light yellow
BR, brown
B, blue
R, red
RT, rust
W, white
P, pink
G, green
O, orange
C, complex spot discussed in the text.

Cheboygan Co. (location 10, Fig. 1). In this area were two populations both somewhat resembling *V. cucullata*. They were temporarily called clone A and clone B. As a result of the original field examination, clone A was thought to be *V. cucullata* and clone B was considered to be something else as yet unidentified. However, when extracts of flowers from both populations were chromatographed, clone B's pattern corresponded perfectly with the pattern of the verified population of *V. cucullata*. Clone B was then reexamined morphologically and determined to be *V. cucullata*. This determination was verified by comparison of the clone B voucher specimen with herbarium specimens.

Clone A's pattern was distinctly different and at that time did not compare with any yet obtained. Specimens of clone A were reexamined morphologically and identified as *V. nephrophylla*. Approximately two weeks after the identify of clone A was determined, an unidentified collection from the lake flats of Cheboygan Co. (location 11, Fig. 1) was chromatographed. The resultant pattern was compared with those previously developed and it was found to coincide with that of *V. nephrophylla*. That this collection was *V. nephrophylla* was verified in the manner previously described.

Of considerable significance in both of these instances was that the correct chromatographic identification preceded the morphological verification in the herbarium.

Viola affinis Le Conte. (Wood Violet)

This species is a complex taxon closely related to *V. cucullata* and *V. nephrophylla*. *Viola affinis* is a very common Michigan violet capable of hybridizing with several other stemless blue violets. Two different collections (2 and 21) were made from populations of this species at location 4, and another collection (11) was made at location 2 (Fig. 1). At each location it was growing intermixed with other relatives with which it can hybridize. Morphologically, these three populations appear to fall basically into *V. affinis*, though population 11 appears to be intermediate between populations 2 and 21. Figures 2 and 3 show the similarities and differences which are chromatographically discernible; however, chromatograms 11 and 21 may not be so different from 2 as they appear graphically, because the streaks may be due to the failure of substances to separate clearly into bands as they did in population 2. It seems evident from the chromatographic and morphological study that the variability is due either to hybridization, which is the most probable cause, or to a natural range of floral pigment variation, either qualitative or quantitative, that occurs in this species. A clearer understanding of the problems involved here, though, will only be obtained by a more intensive study of this species.

Viola sororia Willd. (Woolly Blue Violet)

Russell (1958) greatly expanded the concept of the morphological range of *V. sororia* to include much of what has been considered *V. papilionacea* Pursh. His study of the stemless blue violets, mainly *V. sororia* and *V. papilionacea,* led him to conclude that the former is the common midwestern species and the few wild populations of *V. papilionacea* frequently show the effects of hybridization with *V. sororia.* Hybrid types may be determined by the amount of lamina pubescence, the typical *V. papilionacea* being glabrous and *V. sororia* being pubescent. The two collections of this complex of species came from Oakland Co. (locations 4 and 6, Fig. 1). The specimens from location 6 (population 4) are considerably less pubescent than those collected from location 4 (population 19). This, according to Russell, would indicate that population 4 is perhaps a hybrid between these two species. Chromatographically a pattern difference between the two populations is quite clear and may be interpreted as giving some support to the supposition arrived at by classical taxonomic means.

Viola conspersa Reichenb. (Dog Violet), *V. adunca* Sm. (Sand Violet), and *V. rostrata* Pursh (Long-spurred Violet)

The closest relatives of *V. conspersa* in Michigan are *V. adunca* and *V. rostrata,* both of which are known to hybridize with it. Of these three species, location 4 contained both *V. conspersa* and *V. rostrata* growing in close proximity, while location 7, a jack pine plain in Crawford Co., had only *V. adunca,* and location 11 had only *V. conspersa.* The chromatograms illustrate the pattern differences obtained for these populations. Superficially, all patterns appear quite similar; however, a more careful study reveals that differences exist between the two populations of *V. conspersa* as well as among the various species.

When the pattern differences between the two populations of *V. conspersa* were first noted, the voucher specimens were reexamined to make certain of the original determinations. Both groups were definitely *V. conspersa* and neither appeared to be a recognizable hybrid. The major physical differences between the two groups was their relative size. The plants collected in Cheboygan Co. were uniformly larger with respect to plant height, leaf, petal, and spur length measurements, consistently being near the maximum values presented for the species in Gray's Manual of Botany (Fernald, 1950), while the Oakland Co. population was generally in the minimal range for these same measurements. Other than the possibility of undetected hybridization, this seems to leave two explanations for the pattern differences. The first and the most likely is that this variation represents a natural variability within the species as is reflected by the size differences; the other is that these differences are due to ecological variations associated with diverse habitats. Further study of this group may solve this problem or it may indicate a limitation to the general effectiveness of this method when used on certain species of the violets.

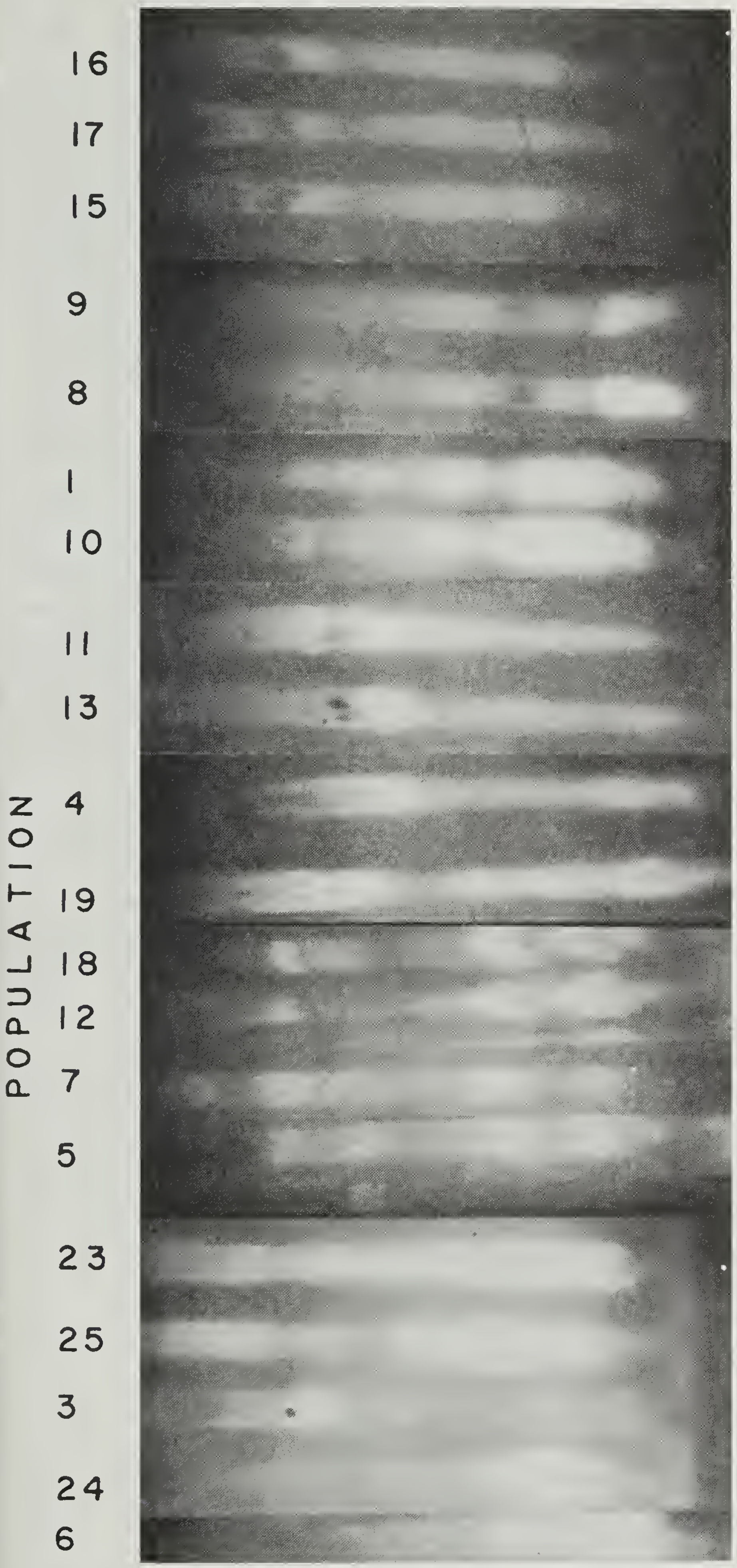
POPULATION
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Fig. 3. Photographs of the fluorescent patterns of:

Viola pedata (16, 17 & 15)
V. sagittata (9 & 8)
V. cucullata (1 & 10)
V. affinis (11)
V. nephrophylla (13)
V. sororia × *V. papilionacea* (4)
V. sororia (19)
V. conspersa (18 & 7)
V. rostrata (12)
V. adunca (5)
V. incognita (23)
V. striata (25)
V. pensylvanica (3)
V. canadensis (24 & 6)

Viola canadensis L. (Canada Violet)

Viola canadensis presents another example of pattern differences within a species. Like *V. pedata,* it appears to be morphologically and genetically distinct. The two areas in which plants were collected are almost three hundred miles apart (locations 4 and 9, Fig. 1). This distance and the possible difference in the stage of development at the time of collection made selection of flowers of similar age a difficult task. One problem, more apparent in this species than in any of the other violets studied, is the noticeable color change in the petals as they age. The young petals are a creamy white and as the flower matures they gradually turn violet. It is probable that this tendency to change color exists to a lesser degree in other violets but it is most readily observable in this species, even when the flowers seem fresh. All plants collected, however, were carefully selected visually for newly opened flowers. It is possible, in spite of this precaution, that unnoticed differences in petal age did occur, resulting in the variations observed in the chromatograms. Chromatographically the species in each case is readily identified by a complex spot near the front. This spot has a yellow trailing edge, a yellow brown region, a pink area, and a light yellow leading edge. Even though pattern differences exist within the species, the presence of this spot provides a means of identifying it.

Viola striata Ait. (Creamy Violet), *V. incognita* Brainerd (Sweet White Violet), and *V. pensylvanica* Michx. (Smooth Yellow Violet)

One population of each of these white or yellow flowered species was sampled and chromatographed twice, mainly to determine if any pattern similarities existed between these species and the blue violets already tested. The results indicate the individuality of the patterns of each of these species and therefore the chromatograms uphold the taxonomic separation that can be determined morphologically. It is interesting to note that Fernald (1950) considers *V. striata* to be very closely related to *V. conspersa,* but the patterns of the two are quite different. *Viola incognita* and *V. pensylvanica* have no close relatives among those violets which were tested.

CONCLUSION

Since the intention of this study has been to determine the feasibility of using floral pigment chromatography as an additional tool in the taxonomy of *Viola,* the results indicate its success. *Viola pedata, V. sagittata, V. cucullata, V. nephrophylla, V. adunca, V. rostrata, V. striata, V. incognita,* and *V. pensylvanica* can be, in the populations studied, distinguished chromatographically. If, when extensive testing of widespread populations of these species is done, these results can be duplicated, the general application of floral pigment chromatography to the taxonomy of this genus will be a very useful and desirable supplement to the conventional taxonomic techniques now employed.

Viola canadensis, V. conspersa, V. affinis, and *V. sororia* have produced results which may indicate a weakness in the application of this technique to complex and variable species of the genus. However, further study of these species morphologically as well as by chromatography may also help to clarify their actual taxonomic position. In general, the results of this work show sufficient success to warrant a more intensive study of the genus chromatographically.

SUMMARY

Plants of one or more populations of each of 13 different species of *Viola* in Michigan were collected and preserved by freezing. Extracts of the petals from each population were made using an extracting solvent of 1 part glacial acetic acid : 99 parts of 95% ethyl alcohol. These were chromatographed using the descending method with an ethyl acetate : t-butanol : water : glacial acetic acid (5 : 4 : 3 : 1, v/v) developing solvent. The chromatographic patterns of fluorescent substances were observed under ultraviolet light, recorded, and their significance in the classification of *Viola* determined. The results of this pattern study permitted chromatographic identification of *V. pedata, V. sagittata, V. cucullata,* and *V. nephrophylla* (based on studies of two or more populations); and of *V. adunca, V. rostrata, V. incognita, V. striata,* and *V. pensylvanica* (based on studies of single populations). *Viola canadensis, V. conspersa, V. affinis,* and *V. sororia* produced patterns that showed variations within the species apparently due to such variables as normal intraspecific genetic variation, hybridization, ecological differences, and petal age. All species tested, however, produced unique patterns. In general, the results are encouraging and suggest the possibility of using this technique as an aid in the classification of the violets.

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PTERIDOPHYTES OF THE HURON MOUNTAINS, MARQUETTE COUNTY, MICHIGAN[1]

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The region around the upper Great Lakes has long been known as a botanically interesting area with a varied flora including three diverse elements: boreal species at their southern limits for the central United States, southern and eastern species at or near their northwestern limits, and a sprinkling of eastern species found east of the Rockies only in a few disjunct stations such as those about Lake Superior. The present contribution is the result of an opportunity to study the pteridophyte flora of an area which contains one of the few remaining major stands of essentially virgin forest in Michigan and which is located in the midst of the Lake Superior region. During the field work, conducted during parts of four summers (1957, 1958, 1959, and 1961), an attempt was made to identify all of the entities occurring there and to determine the types of habitats which each preferred. As was not unexpected in such a transition zone flora, some taxonomic problems were encountered and will be touched upon in the discussion. The report which follows included a description of the area, a brief history of prior botanical exploration, and a discussion of the more interesting pteridophytes, followed by a formal catalogue of the individual taxa.

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[1] This research and publication of the results were made possible through the support of the Huron Mountain Wildlife Foundation, Inc., and the cooperation of the Huron Mountain Club.

Marquette County is situated on the south shore of Lake Superior, near the east-west center of the Upper Peninsula of Michigan. Physiographically the county lies at the eastern edge of the Superior Upland, the term applied to the Laurentian Upland or Canadian Shield where it extends into the Lake States around the western end of Lake Superior. Westward from near the city of Marquette most of the county is a plateau on which the igneous and metamorphic rocks of the Laurentian and Huronian periods are exposed in greatly eroded knobs and ridges. In a belt extending west from the city of Marquette to the western border of the county are many present or former iron mines and their shaft houses, and rock dumps are prominent features of the landscape. Although lumbering and the cutting of hardwoods for the production of charcoal during the early days of iron mining took a heavy toll of the original forest, most of the region now is covered with second growth woodland in which large areas are inaccessible except over the old lumber trails.

Early accounts of the geology of the district applied the name Huron Mountains to all of the rocky knob country north of the iron range. Present usage restricts this name to a somewhat isolated

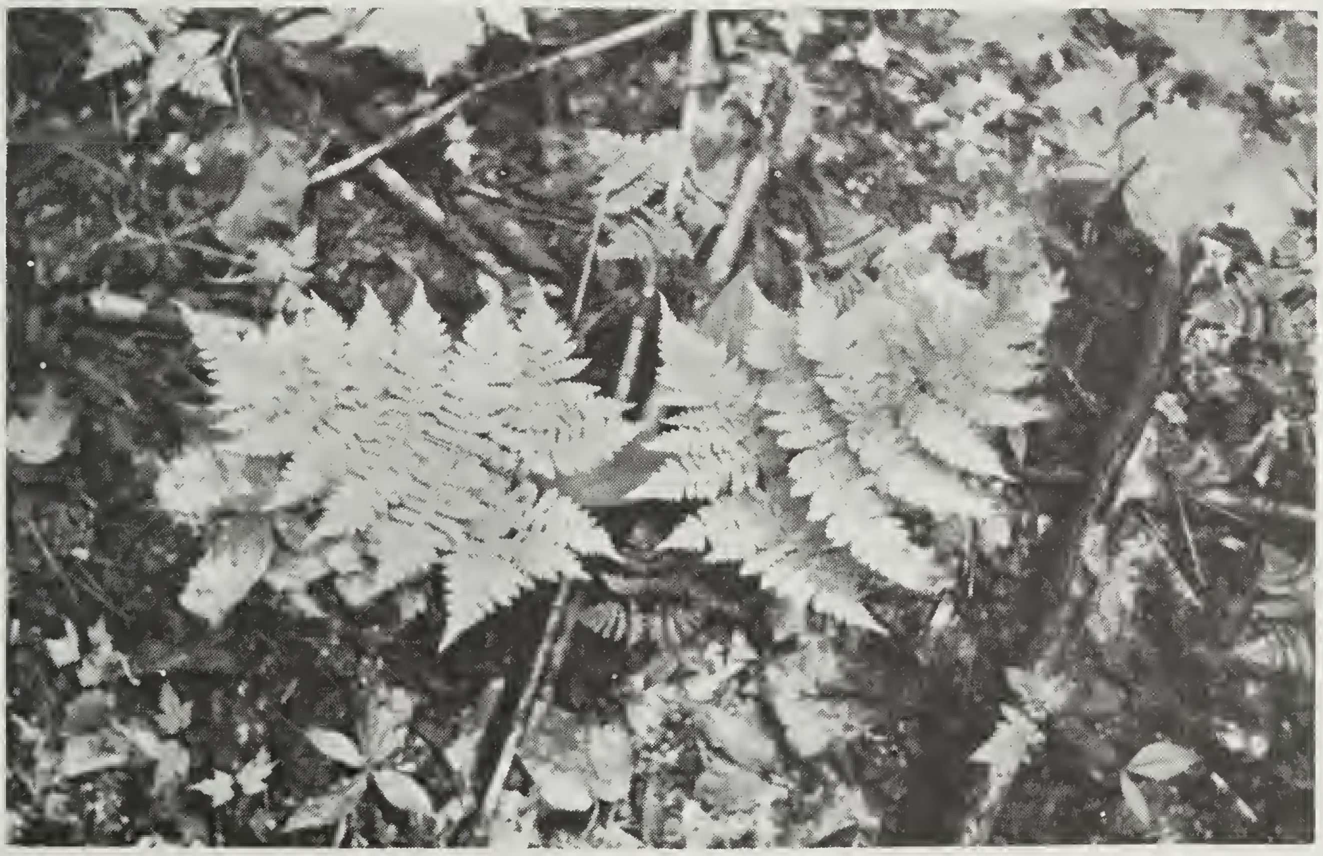

Fig. 1. Huron Mountain *Dryopteris* "*dilatata.*" Note very broad frond. Photo by W. H. Wagner, Jr., June 1961.

group of mostly granitic hills in the extreme northern part of the county. This range, extending northwest from near the town of Big Bay some sixteen miles into the edge of Baraga County, is separated from the rock knob country to the south by the sand plain and moraines north of the Yellow Dog River. Although their maximum elevation is just over 1600 feet above sea level the Huron Mountains rise sharply as much as 900 feet above the narrow strip of lowland which separates them from Lake Superior. These hills, when viewed from the lake shore, as the early voyageurs saw them, have a definitely mountainous appearance. Inland, abrupt changes in local relief combine with the presence of a group of lakes to provide scenery with a rugged charm.

The lakes of the region fall into two groups: those which occupy rocky basins some 150 feet or more above the level of Lake Superior, and a second group on the coastal lowlands, with three of them lying just at the foot of the first range of hills inland from Lake Superior. Several of the lakes have been described in detail by Scott (1921). The largest of the upland lakes, Mountain Lake, is about three miles long, rather narrow, and ringed by steep rocky hills which rise from 300 to 700 feet above its shores. Drainage from the upland lake region is through a series of small streams, on which there are several picturesque waterfalls, into Pine Lake, the largest of the lakes on the lowland. Pine Lake in turn is drained by Pine River, a short stream which cuts through a sand plain formed by a succession of old lake beaches. Drainage of the remainder of the region is by the Salmon Trout River at the south and the Little Huron River at the west. (See map, page 81)

The coastal lowland, from one to three miles in width, is underlain by the Jacobsville sandstone, of Cambrian age. Except along the Lake Superior shore, where it is exposed in a long series of shore cliffs, and around Rush and Howe Lakes, on the lowland, the sandstone has been eroded away or covered by glacial deposits. However, from occasional outcrops along streams (in one place as much as 300 feet above Lake Superior) it may be inferred that the sandstone deposits once reached high up on the flanks of the granitic hills.

The Huron Mountain region is in the transition zone between the eastern deciduous forests and the northern coniferous forests. E. Lucy Braun (1950) classifies the area as part of the Hemlock-White Pine-Northern Hardwoods Region but notes that it differs from more eastern portions of that region in the absence of beech and the prevalence of basswood. In the Huron Mountains proper the principal stands of pine were lumbered around the turn of the century and, beginning about 1919, most of the hardwoods were lumbered, at least by selective cutting. The principal exceptions are tracts owned by the Huron Mountain Club, organized in 1889, whose holdings now total nearly 18,000 acres. The largest remaining tract of original forest consists of about 5,000 acres surrounding Mountain Lake and three

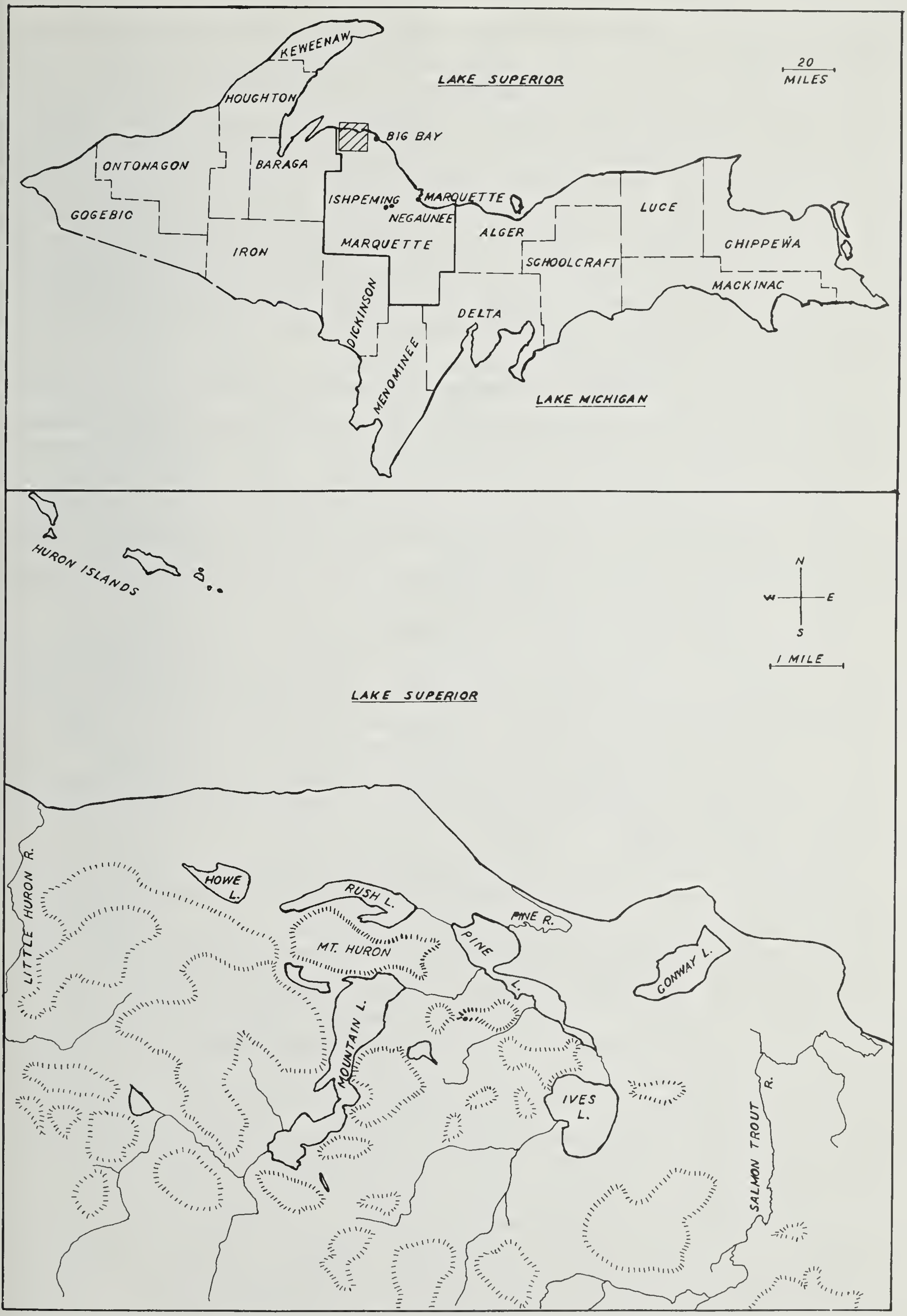
KEWEENAW
HOUGHTON
LAKE SUPERIOR
20
MILES
BIG BAY
ONTONAGON
BARAGA
GOGEBIC
ISHPEMING
MARQUETTE
NEGAUNEE
MARQUETTE
IRON
ALGER
LUCE
CHIPPEWA
SCHOOLCRAFT
MACKINAC
DICKINSON
DELTA
MENOMINEE
LAKE MICHIGAN
HURON ISLANDS
N
W
E
S
1 MILE
LAKE SUPERIOR
LITTLE HURON R.
HOWE L.
RUSH L.
PINE R.
MT. HURON
PINE L.
CONWAY L.
MOUNTAIN L.
IVES L.
SALMON TROUT R.

Fig. 2. Above: Index map showing location of Marquette County, Michigan, and of the Huron Mountain region. Below: Physical features of the Huron Mountain region.

smaller lakes and including the mountain slopes above Pine and Rush Lakes. This area has been designated by the Huron Mountain Club as a Reserved Area to be preserved in its essentially primeval condition. It is forested with hemlock-hardwoods, the proportions varying from nearly pure stands of hemlock on some rocky slopes to nearly solid sugar maple. Other species include basswood, yellow birch, and elm. Another tract of relatively undisturbed forest on the Club property includes some four miles of the flood plain of the Salmon Trout River. This strip contains a mixture of coniferous and deciduous species, among them sugar maple, red maple, elm, black ash, birch, white cedar, and white spruce. This flood plain bears a very rich flora of ferns and other herbaceous plants.

Most of the remainder of the Huron Mountain region is forested with second growth of varying ages and compositions, maple, birch, aspen, white spruce, and balsam fir being the more common species. White and red pines occur sparingly throughout the region while the low sand plain between Pine Lake and Lake Superior is forested with jack pine. Swamp and bog associations are rather limited, the most interesting of the former type being a very wet area along Cedar Creek, at the south end of Mountain Lake.

Through the years there has been considerable interest in the natural history of the region. From time to time investigations have been carried on by members or under the sponsorship of the Club or of various members. Among the published results are a study of the vertebrate fauna by Richard Manville (1948), of the birds of the region by Percival Dodge (1961), and papers on various phases of natural history included in *The Book of Huron Mountain* (B. H. Christy, editor, 1929).

The first comprehensive plant list for the area was that by C. K. Dodge (1918), based on two short collecting trips in 1916 and 1917 and the assistance of local botanists. Dodge listed 43 pteridophytes, of which 38 were attributed specifically to the Huron Mountains. *The Book of Huron Mountain* includes a list complied by Mrs. Wallace Radcliffe, a member who had botanized the area for many years. While based on the Dodge list, it included some additions. Voucher specimens, if any were made, have not been located for some of the species in these lists. In 1940 and 1942 Mrs. Marjorie T. Bingham, then Botanist at Cranbrook Institute of Science, collected extensively in the region and a series of her collections are the basis of a small herbarium maintained in the Club Museum. Others are deposited at Cranbrook (BLH). Rolla M. and Paul Tryon collected pteridophytes during a short visit in 1941. Duplicates of many of their collections were deposited in the Club Herbarium, and additional sets are in the Gray Herbarium, Missouri Botanical Garden Herbarium, and elsewhere.

During the years 1957-59 Mrs. Hagenah and I had the good fortune to spend a total of eight weeks in this region. During the first two years most of the time was devoted to botanizing the Huron Mountain Club property or nearby areas. In 1959 our survey was enlarged to include some geologically different parts of the county, among them a district northwest of Ishpeming in which serpentines occur, and one of ancient dolomites east of Negaunee. Field work in these areas resulted in the finding of some species not previously recorded for the county. Two trips were made to the Huron Islands, a small group of rocky islands about three miles offshore in Lake Superior near the Huron Mountains.

Our field work was spread through the season from late May to mid-August. This proved very advantageous in collecting the Grape Ferns *(Botrychium)*. Among the interesting finds was *Botrychium minganense*, normally a plant of limestone regions, but here found in a grassy hillside clearing at the site of an old lumber camp near the Salmon Trout River. Typical *Botrychium simplex* was found only a few yards away while elsewhere in the clearing both *B. matricariaefolium* and *B. multifidum* were abundant. At two places nearby, along trails near the river, we found typical *B. dissectum*, here at the extreme northern limit of its range in Michigan. (The Keweenaw County record in *Ferns of Michigan* (Billington, 1952) is now referred to another species.) The typical form of *B. dissectum* was found at one other place, under maples along a brook just at the edge of a clearing, and in that place it was accompanied by a few plants of the *obliquum* form. *Botrychium simplex* var. *tenebrosum* was found at two places and *B. lanceolatum* var. *angustisegmentum* in four. With the exception of *Botrychium virginianum* the most common Grape Ferns were *B. multifidum* and *B. matricariaefolium*. Old woods roads and trails proved to be good hunting grounds for both species. In two places in the sand plain near Lake Superior, colonies of *B. multifidum* were found in which there were numerous small plants still attached to the gametophytes. One small colony of *Ophioglossum vulgatum* was found on a grassy hummock at the edge of an alder swamp. During a visit to an old traprock quarry west of Marquette we found a few plants of the Onondaga Moonwort, *Botrychium lunaria* f. *onondagense*.

Woodferns *(Dryopteris)* were abundant, especially on moist wooded slopes and in the swamp and flood plain forests. In 1958 a colony of the Mountain Woodfern was discovered in a moist rocky glen. At that time it was identified as *Dryopteris spinulosa* var. *americana*. The colony was revisited the following year just as the new fronds were emerging. Their somewhat persistent fronds of the previous year drew my attention to certain individual plants as probable hybrids, as other Mountain Woodfern plants did not show any overwintering fronds. One plant of this sort was transplanted to my garden and its hybrid origin was verified cytologically by Dr. W. H. Wagner, Jr., of the University of Michigan. However, the chromosome count indicated that this plant was a hybrid between two diploid species while S. Walker (1959) had reported that *D. campyloptera (D. spinulosa* var.

americana) was a tetraploid. From this we inferred that the Huron Mountain colony of the Mountain Woodfern must represent a diploid variety of the *Dryopteris dilatata* complex instead of the Appalachian entity as previously identified. As the result of this discovery a special trip for intensive study of *Dryopteris* was arranged with Dr. Wagner for June, 1961. The resulting cytological findings and a discussion of their taxonomic implications have been reported in detail elsewhere (Wagner and Hagenah, 1962.). Briefly, the glen from which the hybrid plant had come was found to contain three diploid species--the representative of the *D. dilatata* group here designated as *D. "dilatata"* pending clarification of its relationship within that complex, *D. intermedia,* and *D. marginalis*--and all three possible hybrids, the *D. "dilatata"* × *marginalis* cross being the one which had been found originally in 1959. Another colony of *D. "dilatata,"* found in 1959 nearly four miles from the first colony, when examined plant by plant in 1961 was found to include a single plant with glandular lamina and indusia. This was diagnosed as a possible hybrid with *D. intermedia* but proved in later studies to be a diploid with normal chromosome pairing. Similar plants were frequent in a colony of *D."dilatata"* discovered east of Negaunee in 1961. A transplant from this station proved to be diploid also.

Elsewhere in the Huron Mountains such hybrids as *D.* × *boottii, (D. intermedia* × *cristata), D.* × *slossonae (D. marginalis* × *cristata),* and *D.* × *triploidea (D. spinulosa* × *intermedia)* were found. Of the various parent species, *D. intermedia* is the most common, especially on moist slopes in the hemlock-hardwoods. It varies from narrow, somewhat straightsided fronds to large deltoid fronds which simulate *D. "dilatata"* in some respects and might be keyed out to it by one unfamiliar with that species and dependent upon keys which stress the number of millimeters between the pinnules on the lower pinnae. *Dryopteris marginalis* displays the greatest ecological amplitude, being found in a variety of habitats including the tops of rocky bluffs, talus slopes, wooded slopes, and even, in one place, a flood-plain woods. *Dryopteris spinulosa* is found in swamp woods, sometimes in openings, flood-plain woods, and moist ravines. The presence of plants with very narrow, stiffly erect fronds with a coarse texture and of others with broad, thin-textured fronds creates problems in distinguishing hybrids. *Dryopteris cristata* is the least common, occurring almost exclusively in swamp forests and flood plains. Gametophytes and young sporophytes of the various species were found in profusion in some places, especially on rotting logs, showing the opportunities for reproduction and hybridization in undisturbed forests.

Of the other species of true *Dryopteris* only *D. fragrans* was found on the mainland in the Hurons. In most of the stations it was found on nearly sheer cliffs of igneous or metamorphic rocks, but at Rush Lake it was locally common under the shelter of overhangs along a sandstone conglomerate cliff. The Male Fern, *Dryopteris filix-mas*, had been collected on West Huron Island. On our visits to the island it was found without difficulty and was associated with *D. marginalis*. Hybrids between the two were found. *Dryopteris goldiana* was not found in the Hurons although *Athyrium thelypterioides*, one of its frequent associates in Michigan, is abundant in several places along the flood plain of the Salmon Trout River. *D. goldiana* is known from eastern Marquette County and a large colony was found in a moist valley among dolomitic hills east of Negaunee. In both places the *Athyrium* is present also.

Cystopteris fragilis was found in a variety of habitats, usually on rocks, but occasionally on soil. The terrestrial plants were often nearly hidden by a thick growth of herbs or young maples. Most of the plants in the Hurons were either *C. fragilis* var. *fragilis* or var. *mackayii* but some from the slopes of Mt. Huron were found to have the non-spiny (rugose-verrucose) spore sculpturing of the problematical variety *dickieana*. This spore type has been found to be common in the western United States and to occur sporadically across Canada with a few stations around the upper Great Lakes (Hagenah, 1961). Although *C. bulbifera* was reported by Dodge as "common" it was not found in the Hurons although it occurs in abundance in the dolomitic hills east of Negaunee. A fertile hybrid of *C. bulbifera* and some member of the *C. fragilis* complex was found in the serpentine belt northwest of Ishpeming. Because of their glandular indusia these hybrids have been referred to *C.* × *laurentiana*. Some plants have bulblets with shaggy brown scales similar to those described from other northern Michigan localities (Wagner and Hagenah, 1955).

Woodsia ilvensis was found to be rather common on the granitic hills. On one exposed bluff above Mountain Lake it was growing in close association with *Opuntia fragilis*, a small cactus known in Michigan only on this mountainside. Considerable time was devoted to a search for other Woodsias and at length this effort was rewarded by the finding of *Woodsia oregana* and, on the same cliff, plants which were identified as the hybrid *W.* × *abbeae* by Dr. D. F. M. Brown. These two Woodsias were growing on a south-facing, but partially shaded, group of serried ledges occupying part of a rather precipitous shoulder of Mt. Huron. It is probable that these ledges have a calcareous or neutral soil, for *Juniperus horizontalis*, normally a calciphile, grows on some of the ledges. Subsequently a few scattering plants of each of these Woodsias were found at other localities in the Hurons. *Woodsia oregana* was more common in the serpentine district near Ishpeming and the same area yielded still another species, *Woodsia alpina*. Prior to its discovery here in 1957 by Dr. W. H. Wagner, Jr., it was known from Michigan from only one Keweenaw County collection. Plants with the characters of *W.* × *abbeae* were found here also while still another locality for such hybrids was found in 1961 east of Negaunee. There, on a high cliff, were found hybrids, new stations for both *W. oregana* and *W. alpina*, and the first known Marquette County station for *Pellaea glabella*.

The finding of *Woodsia* × *abbeae* in several new Michigan localities in addition to the Porcupine Mountains, Ontonagon County, where it has been collected by a number of botanists, leads me to believe that the nature of this plant should be re-examined. Supposedly linking the Woodsias with non-articulated stipes, which it resembles, with *Woodsia ilvensis*, of the articulated stipe group, the fronds have a few scales, some glandularity, and long, articulated hairs in which the cell walls are very evident even with a 10× hand lens. The sporangia are abortive. Originally described by Butters (1941) as *W. cathcartiana* × *ilvensis*, it was redescribed as *W. scopulina* × *ilvensis* by Tryon (1948) and this view is accepted by Brown (1958). While *Woodsia scopulina* does occur in Minnesota and Ontario where the hybrid was found first, it has not been found in Michigan. For a sterile hybrid to arise *de novo* repeatedly, ample sources of spores of both parents would seem to be necessary, yet in Michigan one of the supposed parents is lacking. In our localities, *Woodsia oregana*, in the glandular form called *W. cathcartiana* by some, is always present and *W. ilvensis* is never far away, suggesting that these two are the parents despite the articulate hairs. However, in two of the Marquette localities the situation is complicated by the presence of *W. alpina*. Investigation of the Michigan hybrids is being continued.

Probable the most handsome fern seen in the Huron Mountain region was *Polystichum braunii* var. *purshii*, here reaching a truly fine state of development in some of the moist valleys, especially in the sandstone belt where it grows on and alongside huge boulders. It was found in a variety of other habitats also, including hummocks in a swamp forest; in a flood-plain forest along the Salmon Trout River, in association with *Athyrium thelypterioides* in an area where arbor vitae was common; and much to my surprise, a few plants were found in hummocks in a very wet swamp at the mouth of Cedar Creek, an area which would have been impassable on foot if it were not for some plant walkways which had been built for the benefit of fishermen.

Since Quillworts *(Isoetes)* have been but little collected in Michigan it was surprising to find that this genus occurred in nearly all of the lakes in the Hurons. Collections were made in water varying from a few inches to five feet in depth. In some cases the collections were found to contain both *Isoetes muricata* and *I. macrospora*. At one station in Mountain Lake the associated plants included the unbranched form of *Equisetum fluviatile*, *Eriocaulon septangulare*, and *Lobelia dortmanna*. During a visit to the jack pine plains south of the Hurons, I found *I. muricata* to be quite common along the newly exposed shores of two small ponds in which the water level had dropped several inches due to hot, dry weather.

Lycopodiums were common with some localities having three or more species growing together. *Lycopodium lucidulum* was abundant and a few colonies of the so-called variety *occidentale* with narrow entire leaves were found. Typical *L. obscurum* was rare but the var. *dendroideum* and somewhat intermediate plants were plentiful. In the sandy jack pine woods near Lake Superior *L. tristachyum* was common.

Of the Equisetums, ·*E. palustre* was especially interesting because of the great variety of forms, ranging from those with luxurient whorls of branches to clustered unbranched forms. Two hybrid scouring-rushes were found in sandy locations on the lowland. *Equisetum* × *ferrissii (E. hyemale* var. *affine* × *laevigatum)* occurs along the Lake Superior beach and is common on the shore of Pine Lake, while·*E.* × *nelsoni (E. variegatum* × *laevigatum)* is localized at one end of Pine Lake. Of the parent species, only *E. hyemale* var. *affine* is known from Marquette County, so it is probable that these hybrid populations represent vegetative reproduction from water-disseminated plants, with the populations along Pine Lake dating back to the period when that lake was an embayment of Lake Superior.

The annotated list which follows is in three parts. The first section contains the entities known from the Huron Mountains proper or the Huron Islands. Voucher specimens exist for all plants in this list, my own collections being deposited in the herbarium of Cranbrook Institute of Science, with duplicates in the Huron Mountain Club Herbarium. The second section lists those pteridophytes known from elsewhere in Marquette County but which have not been found in the Hurons to date. For the most part these species are calciphiles which have been found in the serpentine or dolomite areas. Voucher specimens are at Cranbrook or The University of Michigan. The third section contains species attributed to the Hurons or the county in earlier publications but for which voucher specimens have not been found or, if found, are now ascribed to some other taxon. Although special attention was given to searching for these species during the present field investigations, they were not found.

Space will not permit listing the many members, guests, and staff members of the Huron Mountain Club who assisted us in various ways. I wish to thank Dr. R. M. Tryon, Jr., of the Gray Herbarium for information about his collections and for checking some specimens deposited there; Dr. E. G. Voss of the University of Michigan for locating some of the C. K. Dodge notebooks; Dr. D. F. M. Brown and Mrs. Joan H. Wilce for checking specimens of *Woodsia* and *Lycopodium*, respectively; and Dr. W. H. Wagner, Jr., and Dr. W. P. Stoutamire for their continued assistance, suggestions, and critical reading of the manuscript. Especial mention is due my wife, who, as my companion during much of the field work, first noticed some of the stations for new and rare species.

Annotated Checklist, Pteridophytes of the Huron Mountain Region and Marquette County, Michigan

An asterisk before the name indicates a taxon first discovered in the county since the start of this investigation in 1957.

Section I. PTERIDOPHYTES OF THE HURON MOUNTAINS AND HURON ISLANDS

OPHIOGLOSSACEAE. ADDER'S-TONGUE FAMILY

*Dissected Grape-fern. *Botrychium dissectum* Spreng. Very rare. The typical form found in three places and the form *obliquum* in one. Only sterile plants seen. The only stations known in the county.

*Lance-leaved Grape-fern. *Botrychium lanceolatum* var. *angustisegmentum* Pease & Moore. Moist, open places in woods and under *Rubus parviflorus* in a grassy clearing. Rare.

Matricary Grape-fern. *Botrychium matricariaefolium* A. Br. Moist woods, especially along old roads and trails. Also in clearings. Occasional.

*Mingan Moonwort. *Botrychium minganense* Vict. One small colony on a grassy hillside. Very rare. Only station known in the county.

Leathery Grape-fern. *Botrychium multifidum* (Gmel.) Rupr. Along old roads and trails in woods, also in clearings. Occasional and sometimes locally abundant in small areas. Variable in size and cutting.

*Little Grape-fern. *Botrychium simplex* Hitchc. Very rare. The typical form on one grassy hillside; variety *tenebrosum* under alders on a sandy lake shore and near a small stream.

Rattlesnake Fern. *Botrychium virginianum* (L.) Sw. The most common grape-fern of the region. In moist woods. Variable in size and cutting of frond.

*Adder's-tongue Fern. *Ophioglossum vulgatum* var. *pseudopodum* (Blake) Farw. A few plants on a grassy hummock at the edge of an alder swamp. Very rare. The only locality known in the county.

OSMUNDACEAE. FLOWERING FERN FAMILY

Cinnamon Fern. *Osmunda cinnamomea* L. Swamps and bogs. Occasional.

Interrupted Fern. *Osmunda claytoniana* L. Moist ground along lakes, streams, and the edges of swamps. More common than the preceding.

Royal Fern. *Osmunda regalis* var *spectabilis* (Willd.) Gray. Swamps, bogs, and lake shores. Sometimes in large colonies.

POLYPODIACEAE. FERN FAMILY

Common Maidenhair. *Adiantum pedatum* L. Usually in moist, somewhat open woods. Sometimes in large colonies. Occasional.

Maidenhair Spleenwort. *Asplenium trichomanes* L. In varied situations on igneous and metamorphic rocks but not found on the sandstones. In both sun and shade. Occasional.

Lady Fern. *Athyrium filix-femina* var. *michauxii* (Spreng.) Farw. Moist woods, swamp margins, lake shores, and along streams. Variable in texture and cutting. Common.

Silvery Spleenwort. *Athyrium thelypterioides* (Michx.) Desv. Moist, frequently alluvial, soil. Occasional but sometimes locally abundant.

Fragile Fern. *Cystopteris fragilis* (L.) Bernh. Both var. *fragilis* and var. *mackayii* fairly common on rocks, the latter also occasional on soil. A few plants from Mt. Huron with the rugose-verrucose spores of the *C. dickieana* type, previously reported from Partridge Island, near Marquette.

Crested Wood-fern. *Dryopteris cristata* (L.) Gray. Usually in swamp woods, but twice seen on rotting logs in moist upland habitats. Occasional.

Mountain Wood-fern. *Dryopteris “dilatata”* (Hoffm.) Gray. Moist, rocky glen and a sandstone ravine in the Hurons. Also in moist thicket at foot of a talus slope east of Negaunee. Some plants are extremely glandular on lamina and indusia. Rare.

Male Fern. *Dryopteris filix-mas* (L.) Schott. Only on the Huron Islands. Collected on the mainland in 1871 near Negaunee (Mary H. Clark, MICH). Rare.

Fragrant Cliff-fern. *Dryopteris fragrans* var. *remotiuscula* Komarov. Occasional on cliffs, on various rocks, including sandstone conglomerates.

Evergreen Wood-fern. *Dryopteris intermedia* (Muhl.) Gray. Abundant on moist, wooded slopes.

Marginal Wood-fern. *Dryopteris marginalis* (L.) Gray. Frequent, especially on rocky bluffs and talus. Also found in a flood-plain woods.

Spinulose Wood-fern. *Dryopteris spinulosa* (L. F. Muell.) Watt. In swamp and flood-plain woods. Frequent. Variable in shape of frond.

Boott's Wood-fern. *Dryopteris cristata* × *intermedia (D.* × boottii. In two swamps. Rare.

**Dryopteris cristata* × *marginalis (D.* × *slossonae).* In two places. Very rare.

**Dryopteris “dilatata”* × *intermedia.* In one place. Very rare.

**Dryopteris “dilatata”* × *marginalis.* In one place. Very rare.

**Dryopteris filix-mas* × *marginalis.* On West Huron Island. Very rare.

**Dryopteris intermedia* × *marginalis.* In one place. Very rare.

**Dryopteris intermedia* × *spinulosa (D.* × *triploidea).* Swamp woods. Occasional. The most frequent of the Wood-fern hybrids.

Oak Fern. *Gymnocarpium dryopteris* (L.) Newm. Moist valleys, sometimes in large colonies. Occasional.

Ostrich Fern. *Matteuccia pensylvanica* (Willd.) Raymond. Frequent along streams and on swamp margins. In one colony some plants attained a height of six feet.

Sensitive Fern. *Onoclea sensibilis* L. Swamp and flood plain areas. Common.

Common Polypody. *Polypodium virginianum* L. Rocky bluffs, talus slopes, and on boulders. Common.

Braun's Holly-fern. *Polystichum braunii* var. *purshii* Fern. Moist woods, hummocks in swamps, flood-plain forests. Occasional.

Common Bracken. *Pteridium aquilinum* var. *latiusculum* (Desv.) Underw. Clearings, roadsides, sandy lake shores and jack pine woods, and open rocky places. Abundant.

Marsh Fern. *Thelypteris palustris* var. *pubescens* (Lawson) Fern. Swamp margins. Seldom seen in fruit. Occasional.

Long Beech-fern. *Thelypteris phegopteris* (L.) Slosson. Moist valleys and flood-plain woods. Occasional.

**Woodsia* × *“abbeae”* Butters. Cliffs and ledges. At two places in the Hurons. Also in serpentine area northwest of Ishpeming and on cliff east of Negaunee. Very rare and local. (See introductory discussion.)

Rusty Woodsia. *Woodsia ilvensis* (L.) R. Br. Cliffs and ledges of crystalline rocks, not on the sandstones. Common.

Oregon Woodsia. *Woodsia oregana* D. C. Eaton. Cliffs and ledges of crystalline rocks, not on the sandstones. Rare and local in the Hurons. More common in the serpentine areas. Also on dolomitic cliff east of Negaunee. The Marquette County plants are mostly of the glandular type sometimes called *Woodsia cathcartiana.*

EQUISETACEAE. HORSETAIL FAMILY

Common Horsetail. *Equisetum arvense* L. Woods, clearings, and waste places. Common. Variable, most collections having the 4-toothed sheaths of var. *boreale*.

Intermediate Scouring-rush. *Equisetum* × *ferrissii* Clute. Sandy lake shores. Occasional.

Water Horsetail. *Equisetum fluviatile* L. The branched form common in swamps; the unbranched form occasional in shallow water in lakes.

Nelson's Scouring-rush. *Equisetum* × *nelsoni* (A. A. Eaton) Schaffner. Sandy shores of Pine Lake. Rare.

Marsh Horsetail. *Equisetum palustre* L. In water in lakes and swamps, occasional but locally abundant. Variable, with both branched and unbranched forms.

Shade Horsetail. *Equisetum pratense* Ehrh. Moist woods, varying from flood plains to steep slopes. Occasional but very local.

Dwarf Scouring-rush. *Equisetum scirpoides* Michx. Moist ground along streams. Occasional but locally abundant.

Wood Horsetail. *Equisetum sylvaticum* var. *multiramosum* (Fern.) Wherry. Moist woods. Occasional.

LYCOPODIACEAE. CLUB-MOSS FAMILY

Bristly Club-moss. *Lycopodium annotinum* L. Moist woods. Both the typical plant and var. *acrifolium* were found. Occasional.

Running Club-moss. *Lycopodium clavatum* L. Woods and clearings. Common.

Running Pine. *Lycopodium flabelliforme* (Fern.) Blanchard. Woods and clearings. Occasional.

Shining Club-moss. *Lycopodium lucidulum* Michx. Moist woods. The typical form is common; the variety *occidentale* is rare.

Ground Pine. *Lycopodium obscurum* L. Woods and openings. The typical variety is rare, but the variety *dendroideum* is common. Plants seemingly intermediate in certain characteristics were found.

Ground Cedar. *Lycopodium tristachyum* Pursh. Sandy and rocky woods. Locally abundant in jack pine woods near Lake Superior.

SELAGINELLACEAE. SPIKE-MOSS FAMILY

Rock Spike-moss. *Selaginella rupestris* (L.) Spring. Open rocky places on the granitic hills. Occasional.

ISOETACEAE. QUILLWORT FAMILY

Spiny-spored Quillwort. *Isoetes muricata* Dur. Sandy lake bottoms. Common.

Large-spored Quillwort. *Isoetes macrospora* Dur. Sandy lake bottoms. Less common than the preceding.

Section II. PTERIDOPHYTES KNOWN FROM OTHER PARTS OF MARQUETTE COUNTY BUT NOT FROM THE HURON MOUNTAIN REGION

*Moonwort. *Botrychium lunaria* Swartz. A few plants of the form *onondagense* at Pine Hill Quarry, between Marquette and Negaunee. Very rare.

Slender Rock-brake. *Cryptogramma stelleri* (Gmel.) Prantl. Locally abundant on dolomitic cliffs east of Negaunee. Also seen in the serpentine region.

Bulblet Bladder-fern. *Cystopteris bulbifera* (L.) Bernh. Reported for the Huron Mountains by C. K. Dodge and Mrs. Radcliffe but not found there. Abundant in moist valleys of dolomitic hills east of Negaunee.

**Cystopteris* × *laurentiana* (Weath.) Blasdell. In the serpentine area northwest of Ishpeming. The presumed hybrid of *C. bulbifera* and *C. fragilis* is discussed by Blasdell (1963).

Giant Wood-fern. *Dryopteris goldiana* (Hook.) Gray. In moist valley in dolomitic hills east of Negaunee. Also at Lake States Forest Experiment Station at Dukes, in the eastern part of the county.

Limestone Oak-fern. *Gymnocarpium robertianum* (Hoffm.) Newm. At Presque Isle Park, Marquette, and in the serpentine area northwest of Ishpeming. At the latter place apparent hybrids with *G. dryopteris* were found (Root, 1961).

*Smooth Cliff-brake. *Pellaea glabella* Mett. On a high cliff in dolomitic hills east of Negaunee, with several Woodsias. Only place seen.

*Northern Holly-fern. *Polystichum lonchitis* (L.) Roth. A few plants in the serpentine area northwest of Ishpeming and a larger colony in a valley in dolomitic hills east of Negaunee.

*Alpine Woodsia. *Woodsia alpina* (Bolton) S. F. Gray. First found on cliffs in the serpentine area northwest of Ishpeming by Dr. W. H. Wagner in company with the writer and others in 1957. A large colony found on a high cliff east of Negaunee by the writer in 1961.

Bog Club-moss. *Lycopodium inundatum* L. Reported for the Huron Mountain region by C. K. Dodge and as frequent throughout the county. No Dodge collection were seen, but collections from Marquette and the southeastern part of the county are at the University of Michigan and the Gray Herbarium. Frequent in the Upper Peninsula of Michigan as a pioneer plant in sandy excavations in moist places.

Section III. DOUBTFUL AND EXCLUDED ENTITIES.

This section contains taxa attributed to the county but for which validating specimens have not been located or for which the voucher is now referred to some other taxon.

Ebony Spleenwort. *Asplenium platyneuron* (L.) Oakes. Reported as *Asplenium ebeneum* in the Radcliffe list. No voucher specimen seen. Possibly based on robust specimens of *Asplenium trichomanes*, as the only Upper Peninsula station known is near DeTour, Chippewa County, some 150 miles to the east.

Broad-leaved Spinulose Wood-fern. *Dryopteris spinulosa* var. *americana* (Fisch.) Fernald. Marquette County was included on the distribution map in *Ferns of Michigan* (Billington, 1952) on the basis of a C. K. Dodge collection from Negaunee. This specimen and similar collections from the Upper Peninsula are now referred to *Dryopteris "dilatata."* (See introductory discussion.)

Christmas Fern. *Polystichum acrostichoides* (Michx.) Schott. Reported by C. K. Dodge from the Sugar Loaf Mountain area, near Marquette, and included in the Radcliffe list for the Huron Mountains. No specimens found. Known from the Upper Peninsula only from an early O. A. Farwell collection from Keweenaw County, one of a group of records which have not been validated by further collections.

New York Fern. *Thelypteris noveboracensis* (L.) Nieuwl. Reported as *Aspidium noveboracense* by Dodge, from the Sugar Loaf Mountain area, and as *Dryopteris noveboracensis* by A. Dachnowski (1907) from several places near the city of Marquette. No Dodge specimens were found but two Dachnowski collections

(MICH) are *Athyrium filix-femina* var. *michauxii.* The nearest known locality is near Tahquamenon Falls, Luce County, more than 100 miles to the east.

Cathcart's Woodsia. *Woodsia cathcartiana* Robinson. In 1955 I reported this taxon from Presque Isle Park, Marquette, but in accord with Brown's treatment of the genus I an now referring this collection to *W. oregana.*

Blunt-lobed Woodsia. *Woodsio obtusa* (Spreng.) Torr. Reported by Dodge from Sugar Loaf Mountain and included in the Radcliffe list for the Huron Mountains. Also reported by Dachnowski (1907) for the Marquette district. Collections by Dodge and Dachnowski were seen in the herbaria of the University of Michigan (MICH) and Wayne State University (WUD) but were *W. ilvensis.* The Radcliffe report may be based on *W. ilvensis.* in similar fashion, or on *W. oregana,* not included in her list.

Variegated Scouring-rush. *Equisetum variegatum* Schleich. Reported from the Huron Mountain region in the Dodge and Radcliffe lists. A Dodge collection from the shore of Pine Lake (MICH) is now referred to *E.* × *nelsoni.* No other collection of *E. variegatum* from the county was found.

Running Evergreen. *Lycopodium complanatum* L. The Marquette County record in *Ferns of Michigan* was based on an L. H. Pammel collection from Ishpeming (PH). Mrs. Joan H. Wilce, monographer of this section of the genus, writes (private communication), "This specimen appeared to me a fairly clear-cut case of a hybrid *L. complanatum* × *flabelliforme*."

Cedar-like Club-moss. *Lycopodium sabinaefolium* Willd. The Marquette County record in *Ferns of Michigan* was based on a Henry Gillman collection from Shot Point, east of Marquette (NY). According to Mrs. Wilce, the specimen is *L. tristachyum.*

Meadow Spike-moss. *Selaginella apoda* (L.) Fern. Reported from the Huron Mountains in the Dodge and Radcliffe lists. Although not uncommon along Lake Michigan no specimens have been found from the region bordering Lake Superior. Dodge says, "Damp, mostly shaded ground," which seems an unlikely habitat as the known collections from the Upper Peninsula are all from rather open shore flats and similar situations. Perhaps some woodland moss was mistaken for *Selaginella.*

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Wagner, W. H., Jr., & D. J. Hagenah. 1962. Dryopteris in the Huron Mountain Club area of Michigan. Brittonia 14: 90-100.

Walker, S. 1959. Cytotaxonomic studies of some American species of *Dryopteris*. Am. Fern Jour. 49: 104-112.

MICHIGAN PLANTS IN PRINT

New Literature Relating to Michigan Botany

The aim of this section is to cover all significant literature relating to Michigan botany published since the beginning of 1960, without attempting much coverage of related fields such as agriculture, conservation, and forestry. When the subject matter or relation to Michigan is not clear from the title, annotations are added in brackets.

B. BOOKS, BULLETINS, SPECIAL REPORTS, AND MISCELLANEOUS

Daubendiek, Bertha, et al. (editors). 1963. The Nature Year in Macomb and St. Clair Counties, Michigan. Macomb Nature Assoc., Mount Clemens. 66 pp. [An unusually attractive booklet, illustrated with pen-and-ink sketches by Robert Butsch, photographs, and maps, with a beautiful color cover, discussing the natural history of the region with special emphasis on seasonal aspects and on conservation. The literature listed for "A Basic Nature Library" and "Other Nature Helps Highly Recommended" represents a very miscellaneous selection which could be greatly improved. It is not clear, for example, why the Cranbrook shrub bulletin is "basic," while the fern and wild flower bulletins are only "recommended," why there is no mention of the best-selling *Mushroom Hunter's Field Guide*, or why the only magazines mentioned are the *National Geographic* and *Michigan Conservation* (why not *Jack-Pine Warbler, Michigan Botanist, Cranbrook News Letter*, etc.?). Proceeds from the sale of this booklet support the worthy sanctuary program of the Macomb Nature Association, from which (at 124 Miller St., Mount Clemens, Michigan) copies may be ordered by mail at $1.25.]

Prescott, G. W. 1962. Algae of the Western Great Lakes Area. rev. ed. Dubuque, Iowa, Brown. 977 pp. [As in the first ed. (see Mich. Bot. 1: 45), basically a manual for Wisconsin and Michigan; revision has been minimal—corrections and improvements but admittedly not including "the many species of algae which have been reported from the Great Lakes area since the 1951 printing." A key to genera of desmids and diatoms is appended. $12.50]

Smith, Alexander H., & Helen V. Smith. 1963. Some Common Mushrooms of Michigan's Parks and Recreation Areas. Mich. Bot. Club. Spec. Publ. 1. 80 pp. [Excellently illustrated guide to common and conspicuous species; see Mich. Bot. 2: 44. Mail orders at $1.25 may be sent to the secretary, Barbara Bowen, 1003 Brooks St., Ann Arbor.]

Sparrow, Frederick K., Jr. 1960. Aquatic Phycomcetes. 2nd rev. ed. Univ. Mich. Press, Ann Arbor. (Univ. of Mich. Stud. Sci. Ser. 15) 1187 pp. [A monumental monograph of aquatic fungi, widely reviewed in other journals. Most geographic citations are only to country, but there are several direct references to Michigan and many bibliographic references which would pertain to Michigan material. $22.50]

Spurr, Stephen H. Forest Ecology. Ann Arbor Publ., Ann Arbor. 1962. 290 pp. [multilith]. [Preliminary version "of a projected book on the ecological foundations of silviculture." Some of the sample data given are from northern Michigan. No index. $4.50]

C. JOURNAL ARTICLES

Palser, Barbara F. 1961. Studies of floral morphology in the Ericales. V. Organography and vascular anatomy in several United States species of the Vacciniaceae. Bot. Gaz. 123: 79-111. [Material of several of the species studied was from localities in Michigan.]

Paterson, R. A. 1960. Infestation of Chytridiaceous fungi on phytoplankton in relation to certain environmental factors. Ecology 41: 416-424. [Study in Washtenaw Co.]

Pomerleau, Rene, & Alexander H. Smith. 1962. Fuscoboletinus, a new genus of the Boletales. Brittonia 14: 156-172. [Four of the species of these fungi are cited from Michigan.]

Sears, Paul B., & Monika Bopp. 1960. Pollen analysis of the Michillinda peat seam. Ohio Jour. Sci. 60: 149-154. [Pollen sequence near Muskegon, dating between the Chippewa and Nipissing stages in Lake Michigan basin.]

D. HISTORY, BIOGRAPHY, EXPLORATION

Anon. 1960. After hours — a biographical exhibit. Cranbrook Inst. Sci. News Letter 29: 54-58. [Very brief notes about 21 persons with scientific avocations, including botanists Cecil Billington, Dale Hagenah, and Paul Thompson.]

Keniston, Hayward. 1962. Harley Harris Bartlett (1886-1960). Am. Philos. Soc. Year Book 1961: 110-114. [A fine appreciation of the University of Michigan's beloved professor, an honorary member of the Michigan Botanical Club.]

McQuate, A. G. 1960. Dr. Edgar Nelson Transeau [obituary]. Ohio Jour. Sci. 60: 253. [Transeau was Professor of Biology at Alma College 1904-1906, after receiving his Ph. D. in botany from the University of Michigan.]

Sears, Paul B. 1960. Edgar Nelson Transeau 1875-1960. Bull Ecol. Soc. Am. 41: 62-64.

Voss, Edward G. 1961. Burt Lake named after Michigan Baptist pioneer. Mich. Baptist 44(2): 7. [Brief sketch of William A. Burt, early surveyor and inventor (whose collections made on surveys near Lake Superior are the basis of one of the earliest publications on the plants of the state and whose further collections from southeastern Michigan are among the oldest extant in the herbarium at Michigan State University).]

Voss, Edward G. 1961. Harley Harris Bartlett. Bull. Torrey Bot. Club 88: 47-56. [Biographical sketch with bibliography of 179 titles.]

Voss, Edward G. 1961. Harley H. Bartlett 1886-1960. Records Genet. Soc. Am. 30: 13-15.

PROGRAM NOTES

MICHIGAN BOTANICAL CLUB

June 7, 8, 9: Spring Campout, Gilbert Lodge at Twin Lakes, west of Traverse City. Field trips, food, and fellowship.

June 16: Annual Meeting of Southeastern Chapter; bus tour, Beal-Garfield Botanical Gardens, Michigan State University.

Sept. 20, 21, 22: Fall campout of Southeastern Chapter, Island Lake Recreation Area.

MACOMB NATURE ASSOCIATION

Sept. 8: Public tours, Lakeville Swamp Nature Sanctuary, 1:30 p.m. on. Park at Lakeville School; tours leave hourly.

MICHIGAN AUDUBON SOCIETY

May 24, 25, 26: "Little" spring campout, Baker Sanctuary, 4 miles south of Bellevue.

Errata

In addition to a few more obvious typographical errors, the following errata have been noted:

Vol. 1: p. 63, line 7: for back read lack
p. 65, line 24: for Campled read Camped
p. 88, line 4 from bottom: for college read collect
Vol. 2: p. 11, lines 11-12: for *delinatum* read *declinatum*
p. 36, line 9 from bottom: for Asia read United States
p. 37 & 41: for 100 times read 1000 times

Editorial Notes

The fourth and final number of THE MICHIGAN BOTANIST for the current year will be the October number. It will include a diversity of shorter articles than those in the present number, which is in large part an extra bonus to our members and subscribers, as the cost of extra pages in one article and the entire cost of another article have been generously subsidized.

Back numbers of THE MICHIGAN BOTANIST are available from the business and circulation manager (see p. 66) at $1.00 each for Vol. 1 (2 numbers) and $.50 each for Vol. 2 (of which this is the third number).

The previous number (Vol. II, No. 2) was mailed on March 8, 1963.

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(On the cover: Fragrant Cliff-fern, Dryopteris fragrans. *Photographed in the Keweenaw Peninsula, Michigan, by E. T. Wherry, 1935; courtesy American Fern Society.)*

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All editorial correspondence and manuscripts should be sent to the editor in chief. Subscriptions and inquiries regarding them (from those not members of the Michigan Botanical Club) should be sent to the circulation manager, Mrs. Roberts, making all remittances payable to "The Michigan Botanist."

Manuscripts intended for publication should be neatly typed, double-spaced. Photographs should show good contrast and detail and be printed on glossy paper. In the effort to achieve uniformity in matters of style and balance in contents, the editors reserve the right to edit all material for publication. Authors should guide themselves by the style in current issues. Manuscripts should be carefully prepared and checked for accuracy before submission, as our method of printing does not include a proof which can be sent to authors. Authors of more than two pages of print in an issue will receive, if requested in advance, five copies of that issue. Arrangements for extracted reprints may be made through the editor,

THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora and to establish suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Inquiries regarding membership may be directed to the state secretary or, from those residing where there is a chapter, to the appropriate chapter secretary. (The Southeastern Chapter is centered in the Detroit metropolitan area; the Huron Valley Chapter, in Washtenaw County; and the Northwestern Chapter, in the northwestern Lower Peninsula.) Dues are modest, but vary slightly among the chapters; in all cases, they include subscription to THE MICHIGAN BOTANIST.

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DISTRIBUTIONS OF DISTINCTIVE SHORELINE PLANTS IN THE GREAT LAKES REGION[1]

Kenneth E. Guire[2] and Edward G. Voss[3]
The University of Michigan, Ann Arbor

There are a number of species of vascular plants which are known in the Great Lakes region entirely (or almost entirely) from the shores of the Great Lakes themselves. During early botanical exploration of the upper Great Lakes area, in the first half of the 19th century, travel was primarily by water. Hence, several of these species, although actually quite restricted in distribution, have been known to science as long as have any plants of the region; and the type localities for some of them, including of course the endemics, lie in our area.

It is interesting to note that the species which are restricted to shorelines around the Great Lakes are quite varied in their total distribution patterns in North America. Some of them, in other portions of their range, are not even restricted to shoreline habitats. In the following maps and notes, we attempt to present as reliable information as is available on the distribution of the most distinctive shoreline species, grouped wherever possible according to the overall patterns of distribution which they represent, although nearly every species has its distinctive phytogeographic features and any grouping is highly artificial.

INTERPRETATION OF THE MAPS, AND ACKNOWLEDGMENTS

Solid circles on the maps represent specimens examined by either or both authors in the following herbaria, to the curators of which we are indebted: Cranbrook Institute of Science (BLH), University of Michigan (MICH), Michigan State University (MSC), University of Toronto (TRT), University of Michigan Biological Station (UMBS), Wayne State University (WUD). Solid circles for *Cakile* in Ohio represent specimens examined in the herbarium of Ohio State University (OS) in the course of special work on that genus by Ronald L. Stuckey, who also supplied records from OS for other species and in addition participated in our field work in July of 1962.

Half-circles on the maps represent additional significant records from personal correspondence or literature which we consider reliable. Questionable literature records are not here repeated if we have been unable to authenticate them through examination or contemporary correspondence. We are grateful to the following for courtesies in correspondence regarding specific points: W. Preston Adams (DePauw University), E. Lucy Braun (Cincinnati, Ohio), Arthur Cronquist (New York Botanical Garden), Hugh H. Iltis and Mrs. K. S. Snell (University of Wisconsin), R. J. Moore (Canada Department of Agriculture), J. Patman (University of South Florida), A. E. Porsild (National Museum of Canada), James H. Soper (University of Toronto), A. E. Waller (Ohio State University), and Carroll E. Wood, Jr. (Harvard University).

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[1] Papers from the Herbarium and Department of Botany, The University of Michigan, No. 1148, and Contribution from the Biological Station of The University of Michigan. The cost of printing additional pages in this article has been defrayed by the Asa Gray Bulletin Fund, originated by the late Professor H. H. Bartlett.

[2] National Science Foundation Undergraduate Research participant, 1962.

[3] Curator in Vascular Plants, University Herbarium.

For the three endemics of the region (*Cirsium pitcheri, Iris lacustris*, and *Solidago houghtonii*), the maps show the entire distribution of the species. For the remaining species, the maps show all records known to us from the area covered by the base map, but it should be understood that there are additional stations beyond that area. We are indebted to Dr. Henry Imshaug of Michigan State University for kindly permitting the use of his base map. The horizontal and vertical lines represent one degree of latitude and longitude, respectively.

To avoid even greater congestion of dots on several of the maps, some known localities have not been represented, where the symbols would only mean extensive overlapping of other dots.

I. ENDEMIC SPECIES

Iris lacustris Nuttall — Dwarf Lake Iris

MAP 1. The type locality of this species is Mackinac Island, where it was found by Thomas Nuttall in 1810 (see Voss, 1956, p. 22). It is almost entirely restricted to more or less shaded areas near the shores of Lakes Michigan and Huron, being known from three slightly inland sites in Michigan: Presque Isle Co., sparse pine woods on rocky limestone plains, sec. 17 & 20, R7E, T34N [ca. 2 mi. inland] (*McVaugh 9233*, MICH, UMBS); Menominee Co., gravel ridge among aspens at Koss [ca. 14 mi. inland] (*Voss 4044*, MICH, MSC; first found here by Davis in 1905, MICH); and Delta Co., calcareous east bank of Escanaba River ca. 1 mi. NE of Cornell [ca. 10 mi. inland] (*Voss 5982*, MICH, BLH; first found [presumably here] by Wheeler in 1892, MSC, "bank of Escanaba River ten miles from Escanaba.")

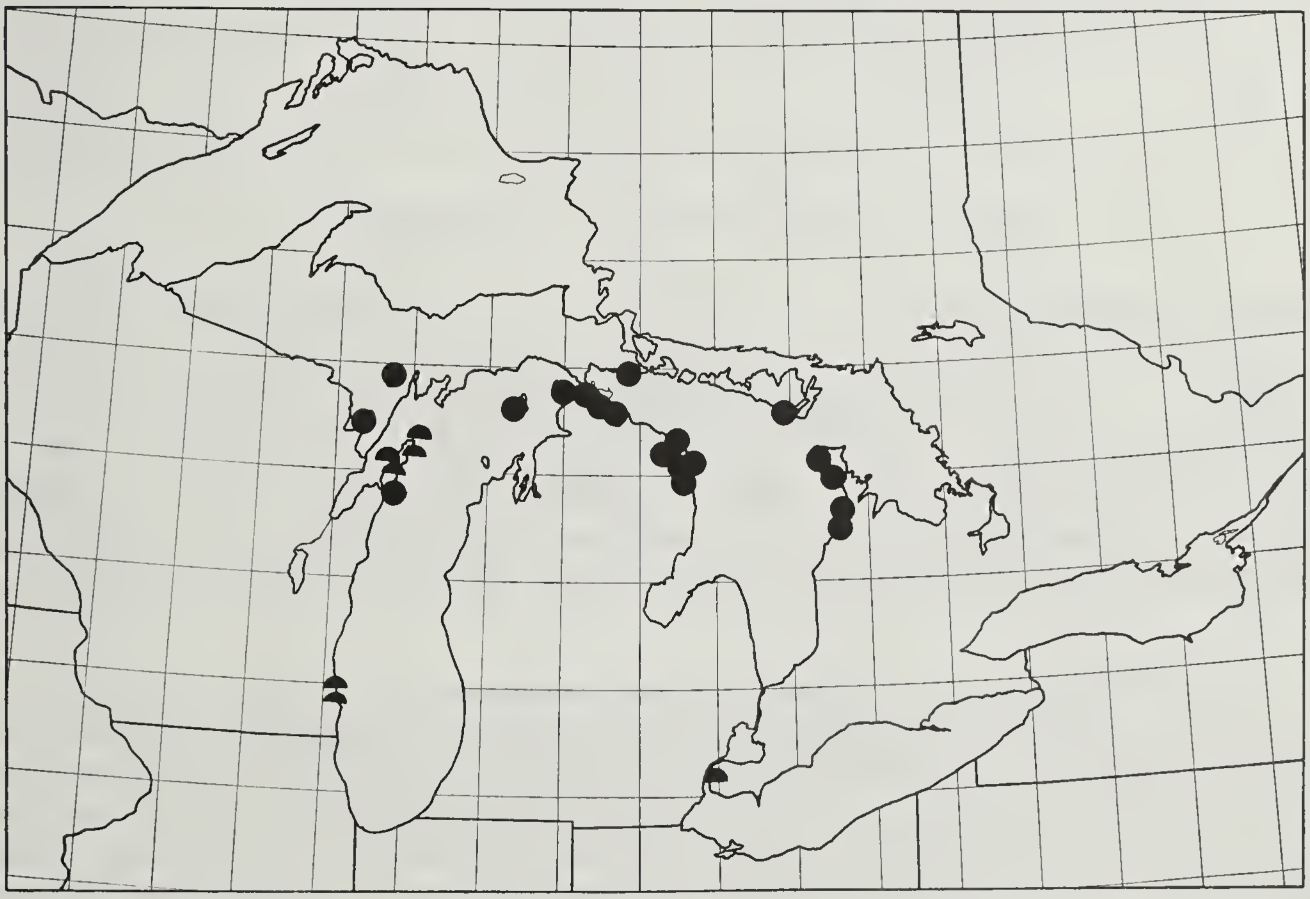
The record mapped from the vicinity of Windsor, Ontario, is based on a fruiting specimen in the Canadian National Herbarium: "Sand at Sandwich, Ont. John Macoun, August 20, 1901. No. 82,302." We have not seen the specimen, but it has been checked by Dr. Porsild, who affirms that the determination is correct and that the record is apparently acceptable.

Since the 7th (1908) edition of *Gray's Manual*, the range of *I. lacustris* has been given in manuals as including the shores of Lake Superior; the 8th edition of *Gray's Manual* (Fernald, 1950) more explicitly refers to Wisconsin. We have been unable to verify the occurrence of this species anywhere around Lake Superior, and believe that it should not be attributed to that Lake. Dr. Wood advises us that there are no specimens of *I. lacustris* from the Lake Superior area in the Gray Herbarium, and Dr. Cronquist reports likewise from the herbarium of the New York Botanical Garden. Only Lake Michigan records are reported by the University of Wisconsin, and Fassett's *Spring Flora of Wisconsin* says "Lake Michigan region."

Waller (1931, p. 43) maps *I. lacustris* as occurring in Cuyahoga County in northeastern Ohio, in two inland Michigan counties in the Lower Peninsula, and in the entire eastern part of the Upper Peninsula of Michigan, including the Lake Superior area. These records were apparently accepted without question by Foster (1937, pp. 11 & 12). Waller (p. 35) refers to "the type specimen collected by Krebs" in Cuyahoga County. However, the type locality is northern Michigan, not Ohio; this species was not listed by Krebs for Cuyahoga Co. (Ann. Rep. Ohio Acad. Sci. 3: 24-26. 1895); and it was not listed for Ohio by Dykes (1913, p. 106), who does cite a Cuyahoga County collection (by Krebs) of *I. cristata* in the Berlin Herbarium—where Waller stated that his *I. lacustris* would be. Waller (in litt., 1963) is unable to supply any further information regarding this record. In the absence of any supporting documentation, the inland and Lake Superior Michigan distributions indicated on his map, as well as the Ohio record, may be safely disregarded on the basis of present knowledge of the distribution of this species.

Cirsium pitcheri (Eaton) Torrey & Gray Pitcher's Thistle

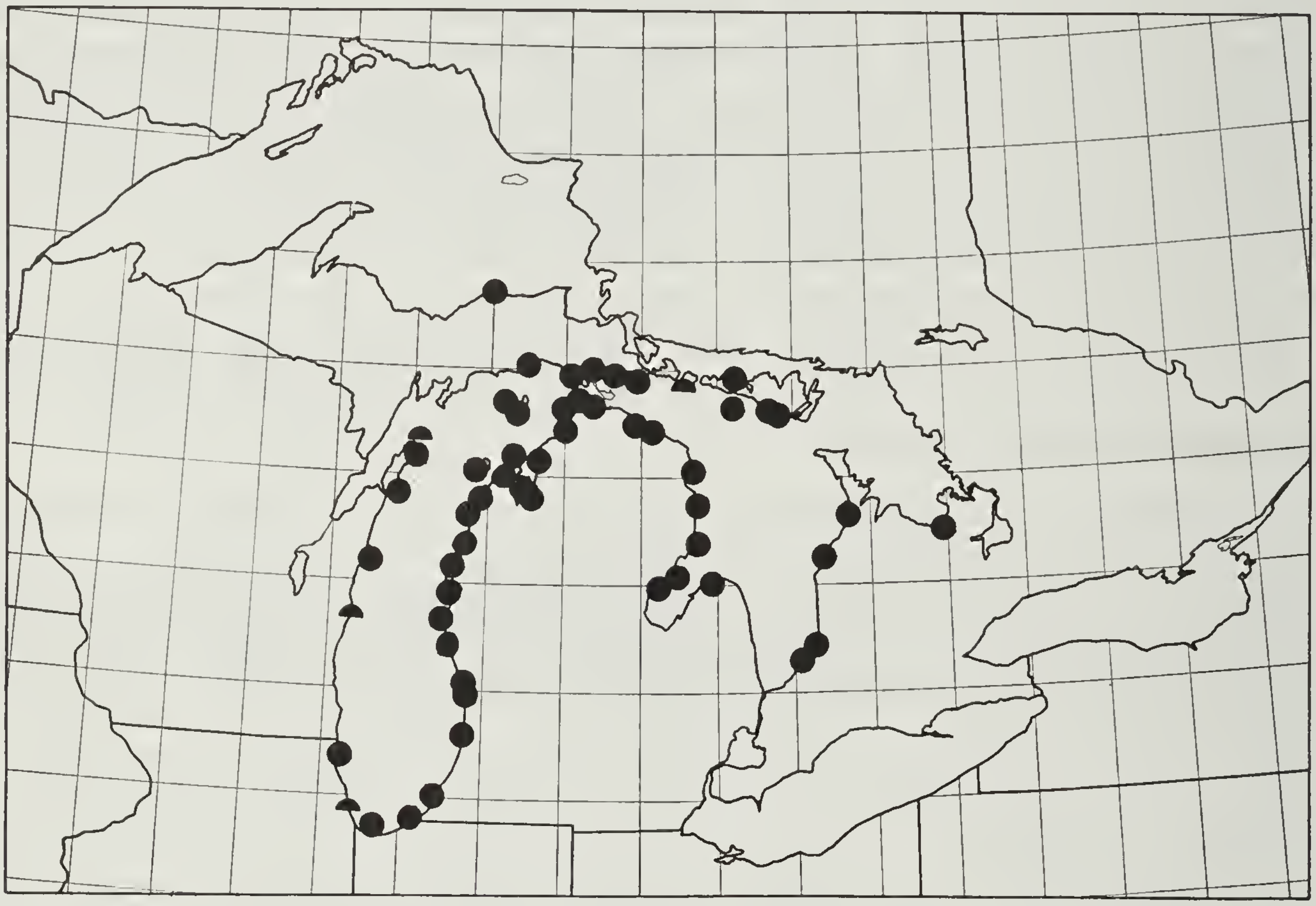
MAP 2. The type locality of this handsome cream-flowered thistle of beaches and dunes is also apparently Mackinac Island (see Voss, 1956, pp. 24-25), whence Eaton's material must have come. However,



Map. 1. Distribution of *Iris lacustris*.

the name was first proposed (though not actually published) by Torrey, honoring Dr. Zina Pitcher.[4]

Pitcher found this thistle "on the great sand banks of Lake Superior." Presumably this was while he was stationed at Fort Brady, and the locality thus described must surely be the Grand Sable dunes, in Alger County, Michigan. This remains the only Lake Superior locality known for this species, which is locally frequent on the high sandy moraine and perched dunes west of Grand Marais. Intensive search by us on sandy shores between Grand Marais and Whitefish Point has failed to reveal any additional stations for this species.



Map. 2. Distribution of *Cirsium pitcheri*.

Solidago houghtonii Gray Houghton's Goldenrod

MAP 3. This large-headed goldenrod occurs primarily in interdunal areas near the shores of Lakes Huron and Michigan. The type locality is the north end of Lake Michigan (Mackinac Co., Michigan), somewhere between four miles southeast of Epoufette and four miles west of Naubinway (see Voss, 1956, pp. 27-28). This was the portion of shore followed on August 15, 1839, by Douglass Houghton, for whom the species is named. (The undated type is in the Gray Herbarium; an isotype at the University of Michigan has the date.) Thus honoring Michigan's famed first State Geologist and collected in the course of his first survey of the state, *S. houghtonii,* like the other two endemic species, is closely associated with the early scientific history of the region.

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[4] After graduating in medicine from Middlebury College in 1822, Pitcher was an Army surgeon for 15 years, which included assignment to Fort Brady (Sault Ste. Marie). Beginning in 1837, Pitcher was one of the first Regents of the University of Michigan, and is credited with the report whose acceptance meant the establishment of a medical school; he was one of the three founders [with Lewis Cass and Henry Rowe Schoolcraft] of the Historical Society of Michigan; was a president of the state medical society and of the AMA; and altogether one of the leading citizens of the young state of Michigan.

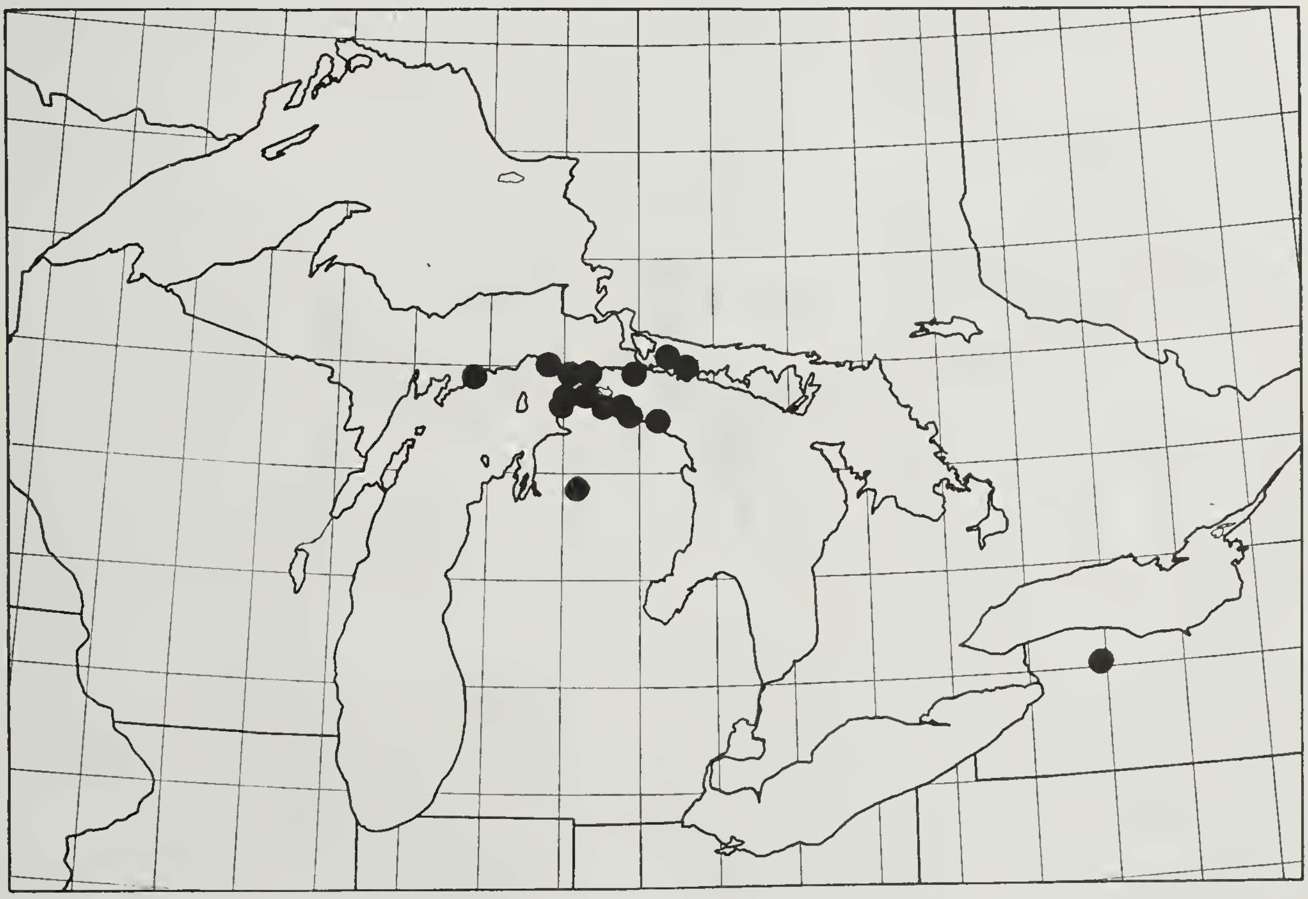
Only two inland locations are known for *S. houghtonii.* For many years it has been known from Bergen Swamp in New York state, a locality remarkably disjunct from the remainder of the range. More recently, it has been collected on the sandy shores of tiny Howe's Lake in Crawford County, Michigan (*Somerville 1933,* WUD; *Voss 11008,* MICH, MSC, BLH, UMBS, TRT).

II. COASTAL SPECIES

Considered in this group are those species which, in addition to their occurrences on shorelines of the Great Lakes, are found on one or more ocean shores--and sometimes the shores of very large freshwater lakes.

Tanacetum huronense Nuttall Lake Huron Tansy

MAP 4. This species, like *Iris lacustris,* was described by Nuttall, who had found it on (or near) Mackinac Island during his 1810 expedition. The typical variety, known from northern Michigan, adjacent Ontario, and the Door Peninsula of Wisconsin, may be considered an



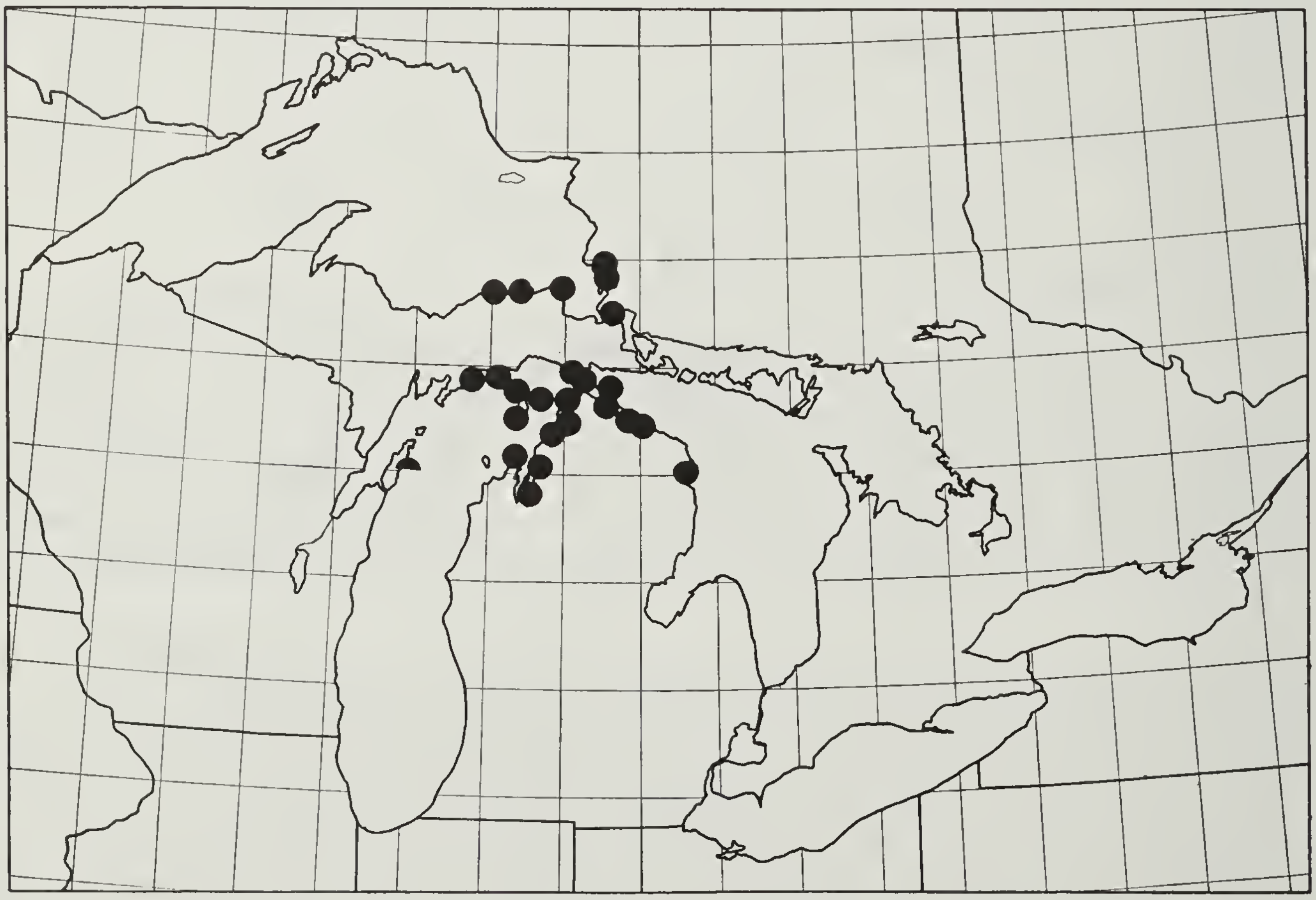
Map. 3. Distribution of *Solidago houghtonii.*

endemic variety of a widely dispersed species (see Fernald, 1935, pp. 333-334). Closely related varieties or species are known from the shores of Hudson Bay, the north Atlantic coast, and Alaska (see Hultén, 1950, pp. 1551-1552). It is perhaps surprising that a plant of such northern distribution is not more widespread on the gravelly and sandy shores of Lake Superior and northern Lake Huron.

Elymus mollis Trinius Dune Grass

MAP 5. Another species of northern affinities, widespread on Arctic shores and ranging south to Massachusetts, Oregon, Hudson Bay, and Lake Superior, this very stout glaucous grass is found on sandy shores and dunes. Our field work has confirmed its occurrence in Michigan locally all along the sandy shore from Whitefish Point to Chapel Beach in the Pictured Rocks area; it is more frequent than the few earlier collections would indicate.

Statements in current manuals notwithstanding, there seem to be no authentic records of *E. mollis* from Lakes Michigan or Huron. Reports from south of Lake Superior are, so far as known, based on the introduced European *E. arenarius* L. (of which *E. mollis* is sometimes treated as var. *villosus*, although differing in chromosome number and other characteristics). A taxonomic treatment of the group, with a small-scale map of the total range of the species, is provided by Bowden (1957). A map is also in Hultén (1962, p. 197).



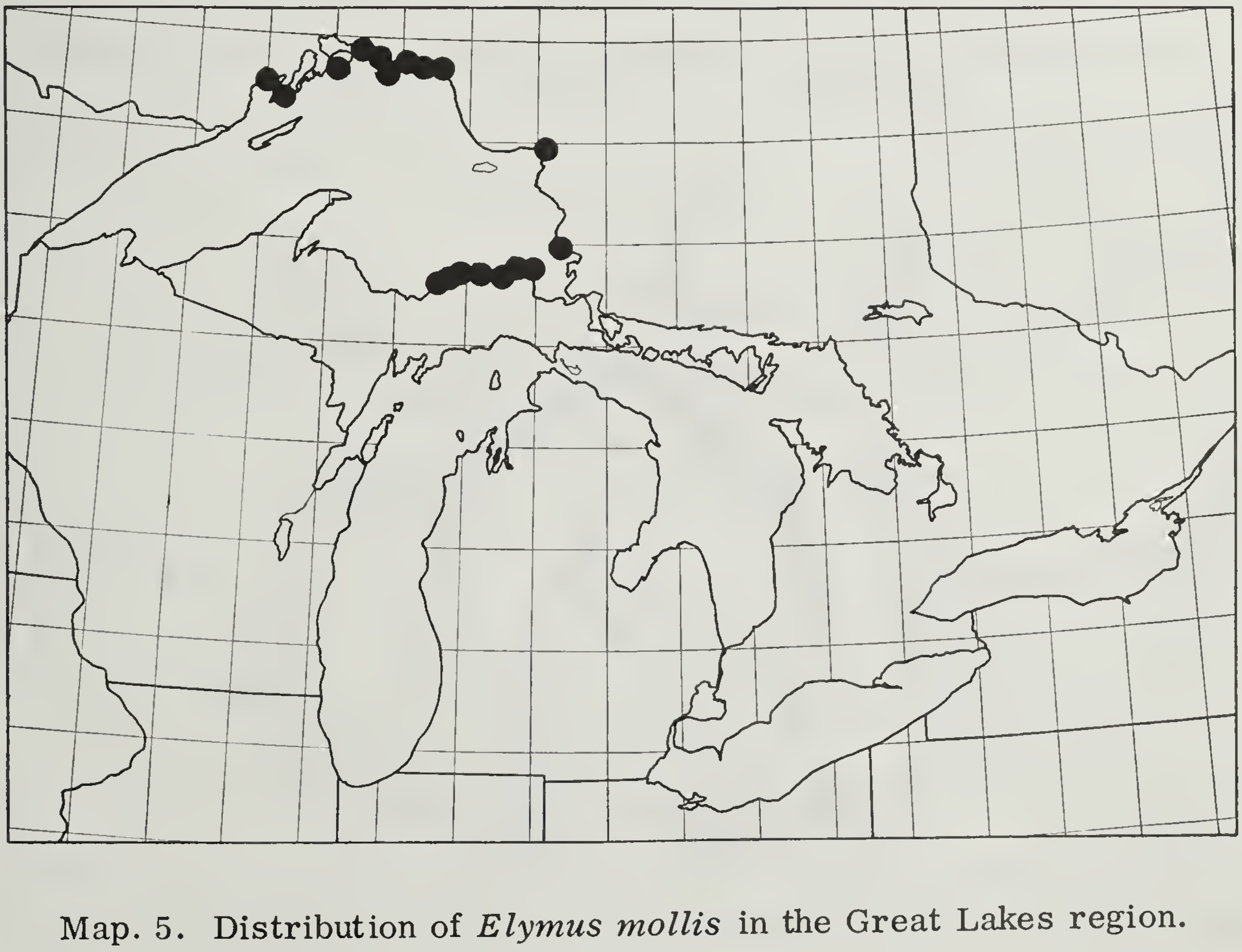
Map. 4. Distribution of *Tanacetum huronense* in the Great Lakes region.

Ammophila breviligulata Fernald Beach Grass

MAP 6. This is one of the very few shoreline species commonly known from all five of the Great Lakes, and it is in addition found on the Atlantic coast from Newfoundland to North Carolina, on Lake St. John, Quebec, and Lake Champlain. In spite of its abundance on dunes along the Great Lakes, the only known inland locality seems to be the east shore of Douglas Lake, Cheboygan Co., Michigan *(Ehlers 1217,* MICH). An excellent sand binder, its rhizomes are both horizontal and vertical and may grow as much as eight feet in a single year as sand accumulates (F. C. Gates, unpublished).

Lathyrus japonicus Willdenow Beach Pea

The Great Lakes distribution of this species is essentially similar to that of the preceding, as it is also known from all five of the Lakes. It is somewhat more frequent on Lakes Erie and Ontario and the north shore of Lake Superior than *Ammophila.* Small-scale maps showing distribution of two of the varieties in North America are given by Fassett (1939, pp. 116 & 118). Altogether, this American relative of the European beach pea, *Lathyrus maritimus* (from which it is sometimes considered not specifically distinct), occurs at Lake Champlain, Lake St. John, and some other lakes (including Lake Winnipeg) besides the Great Lakes, as well as the lower St. Lawrence valley, from Newfoundland to New Jersey, and from Alaska to Oregon.



Map. 5. Distribution of *Elymus mollis* in the Great Lakes region.

Cakile edentula (Bigelow) Hooker Sea-rocket

MAP 7. This fleshy crucifer is widespread around four of the Great Lakes, but on Lake Superior is known only from the beach at the Huron Mountain Club, Marquette Co., Michigan (*Bingham* in 1942, BLH; *Stoutamire 3143*, BLH; *Bourdo 3218*, MSC). Its usual habitat in our region is on sandy beaches among the plants nearest the water's edge. The only inland collection we have encountered is from Puslinch Lake, Wellington Co., Ontario (*Stroud* in 1937, TRT). The species occurs along the Atlantic coast from Labrador to South Carolina, as well as on the Pacific coast. We have not attempted to distinguish var. *lacustris* and typical var. *edentula* on the map. Both occur in the Great Lakes area, and the former could be considered an endemic variety. Very few of the dots on the map represent the latter (see Patman, 1961, pp. 34-35).

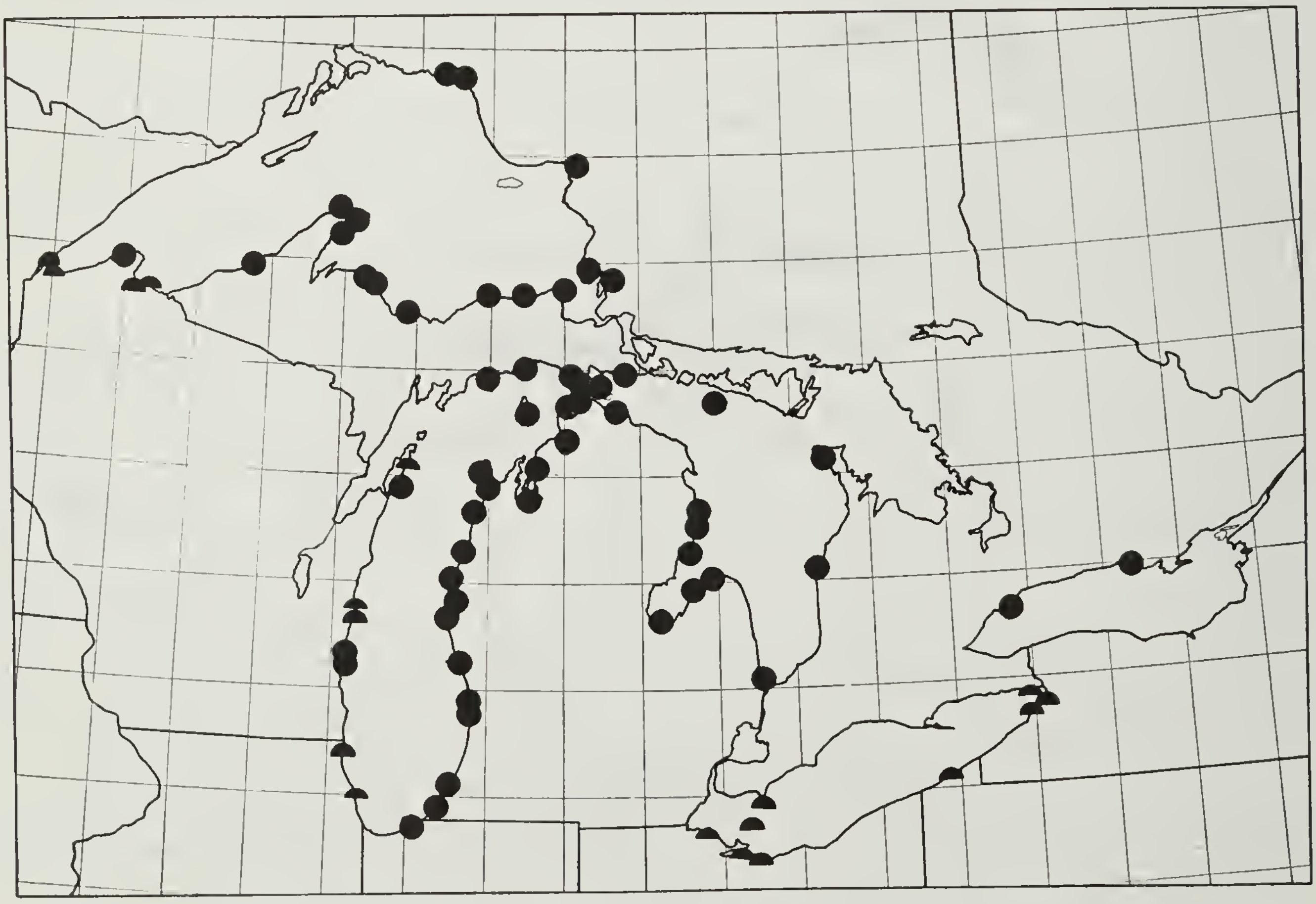
Euphorbia polygonifolia Linnaeus Seaside Spurge

MAP 8. This prostrate little plant is found with essentially the same distribution around the lower four Great Lakes as the preceding. It is also along the Atlantic coast from Quebec to Georgia. A small map is in Wheeler (1941, p. 249).

III. WESTERN SPECIES

Calamovilfa longifolia (Hooker) Scribner Longleaved Reedgrass

The typical variety of this tall grass, with nearly glabrous sheaths and contracted panicle, grows on sandy soil and prairies from western

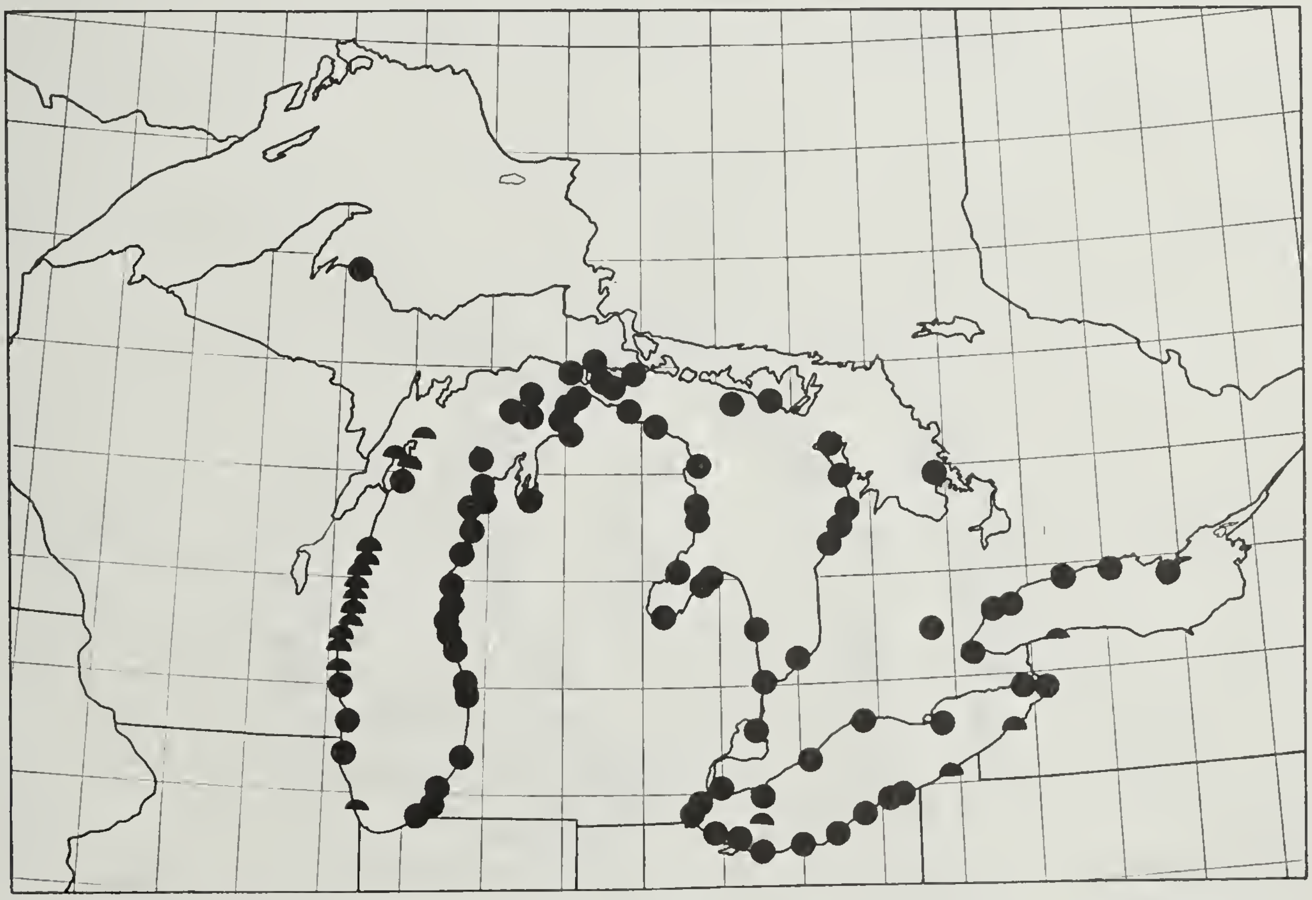


Map. 6. Distribution of *Ammophila breviligulata* in the Great Lakes region.

Wisconsin to Colorado, Alberta, and British Columbia—not at all a shoreline distribution. It is occasionally adventive eastward along railroads and in waste ground. However, on the sandy shores and dunes of the Great Lakes is var. *magna* Scribner & Merrill, with hairy sheaths and an open panicle. The latter, then, is a distinctive variety largely endemic around the Great Lakes (see Shinners, 1943, p. 782; Thieret, 1960). The type locality of var. *magna* is the lake shore at the mouth of the Kalamazoo River [Allegan County], Michigan. This grass is widespread around Lakes Huron and Michigan, with one record each from Lake Erie (Dodge, 1914, p. 19) and Lake Superior (Huron Mountain Club, *Bingham* in 1940, BLH). A map has been published by Thieret (1960, p. 173), who shows the inland locations known in northwestern Indiana, Illinois, southeastern Iowa, and southwestern Wisconsin.

Agropyron dasystachyum (Hooker) Scribner Thickspike Wheatgrass

This attractive blue-gray native relative of the obnoxious quackgrass (*A. repens*) has an even wider distribution on dry soils from the Dakotas westward (reportedly to Arizona and Alaska) than *Calamovilfa.* Like the latter, it has a disjunct variety on shores and dunes of the Great Lakes. This has been described as a distinct species (*A. psammophilum*) by Gillett and Senn (1961), on the basis of more glaucous foliage, more villous lemmas, and more attenuate glumes than typical plants from the western plains. (An awned form is known along the Lake Huron shore in Michigan from St. Clair Co.



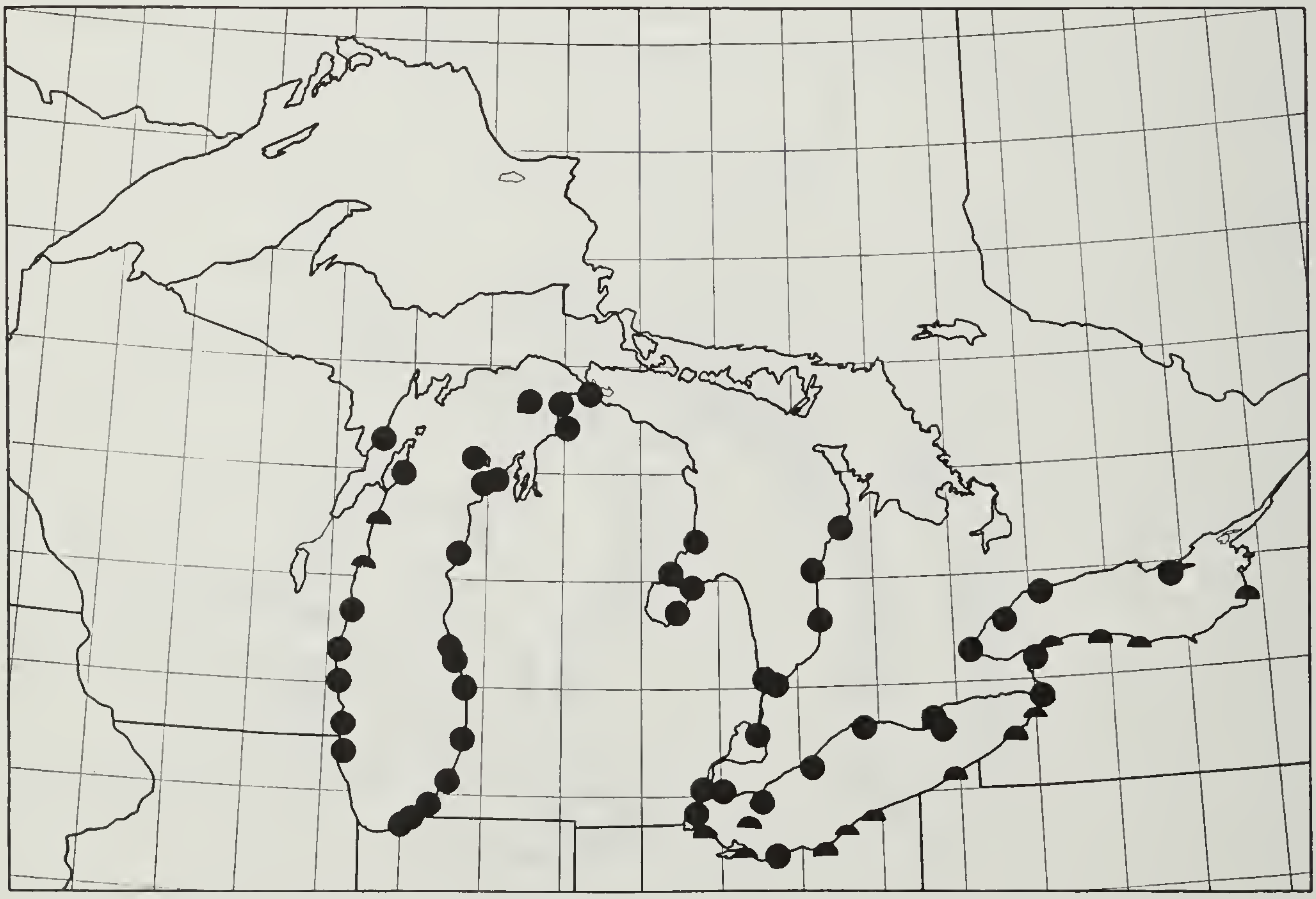
Map. 7. Distribution of *Cakile edentula* in the Great Lakes region.

to Presque Isle Co., and also from Lake Superior.) The only known Lake Superior records are Farwell's from the Keweenaw Peninsula, cited by Gillett and Senn, who omit them from their distribution map (1961, p. 1172) because of doubt as to their acceptibility. All we can add is that duplicates of the cited collections are also in the herbaria of the University of Michigan and the Cranbrook Institute of Science, so if they are an instance of Farwell's unreliability they are at least a very consistent one. Furthermore, he cited these collections in Rep. Mich. Acad. 21: 355 (1921).

Bromus pumpellianus Scribner Pumpelly's Bromegrass

MAP 9. Both the taxonomic and geographic status of this plant are in question. Wagnon treats it as a native subspecies of the widely naturalized *B. inermis*, with which it apparently hybridizes. The chief differences are the conspicuously villous lemmas, pubescent leaves and nodes, and often well developed leaf auricles in *B. pumpellianus*. Occasional specimens have glabrous nodes but these may have the lemmas very villous and even the glumes more or less hairy (e.g., specimens from Leelanau Co., Michigan).

Doubt has been expressed as to whether the species is native in this region, the *Manual of Grasses* flatly saying "introduced in Michigan." Plants on shores and dunes from the Straits of Mackinac to Leelanau County, including Beaver Island in northern Lake Michigan, certainly appear to be indigenous. The Lake Superior localities are suspect, at least the easternmost two of them being along railroad tracks (Port Coldwell, *Taylor et al. 865*, TRT; and Heron Bay, *Taylor*



Map. 8. Distribution of *Euphorbia polygonifolia* in the Great Lakes region.

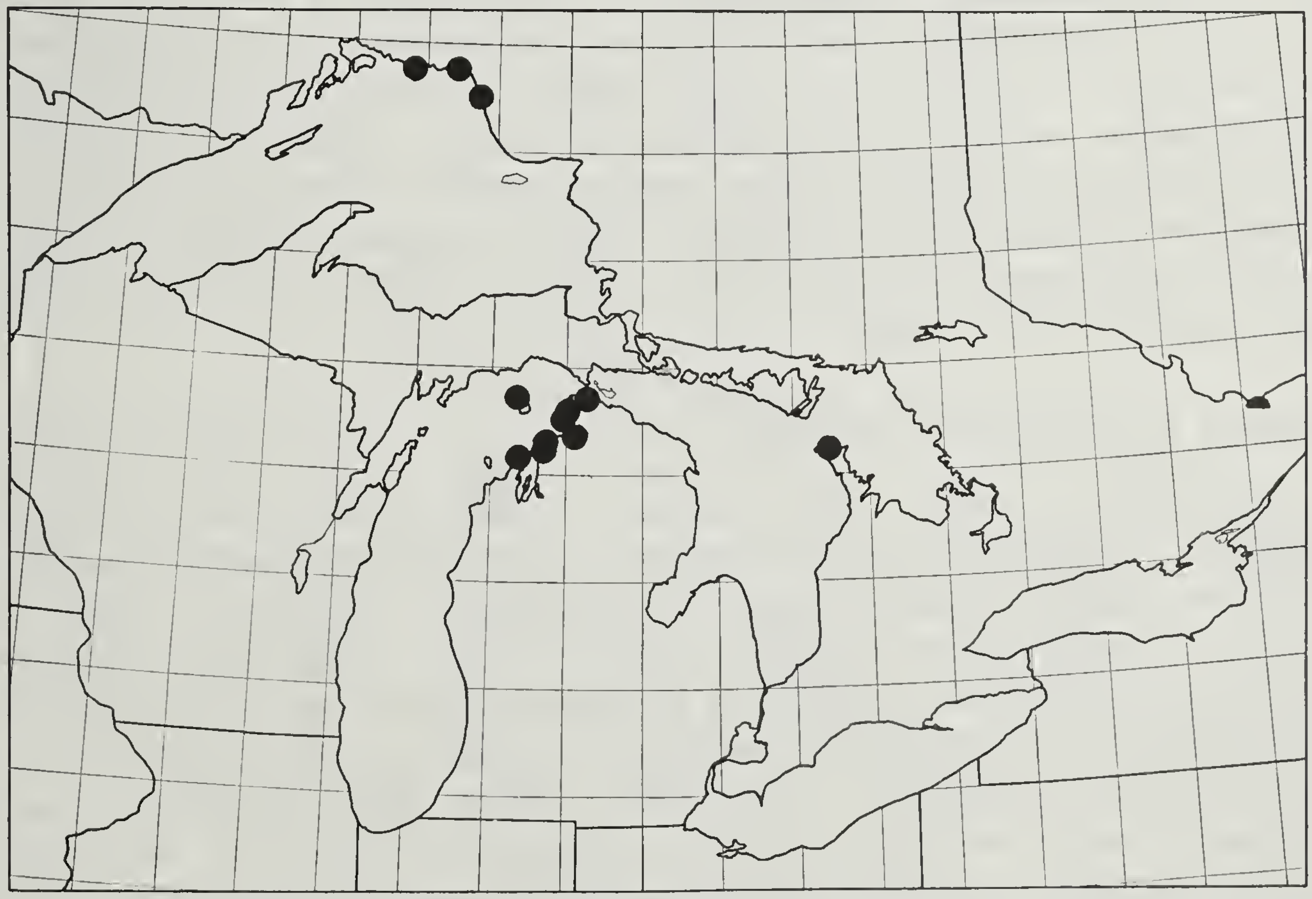
et al. 866, TRT). It is likely that plants here are adventive from the native range of *B. pumpellianus* in the west (Rocky Mountains and Black Hills north to Alaska). We include a map, even though others have been published by Elliott (1949, p. 142) and Wagnon (1952, p. 453). Lake Superior localities are not shown by Elliott, and Wagnon apparently assumes that they are on Thunder Bay (north of Isle Royale) whereas they are merely in the "Thunder Bay District"—which encompasses a very large area. Furthermore, there are additional Michigan specimens to map, and it is worthwhile to call attention once again, with a corrected map, to this often overlooked and problematic plant. The record from Ottawa, Ontario, is a specimen collected by Fletcher and in the herbarium of the New York Botanical Garden, according to Wagnon (1950, p. 193).

Corispermum hyssopifolium Linnaeus Bugseed

Like other members of the Chenopodiaceae, this species has a tendency to be weedy, a habit doubtless associated with the numerous inland localities for it. However, it has a normal range which includes the shores of Lakes Erie, Huron, Michigan, and Superior, as well as sandy areas to the west.

Orobanche fasciculata Nuttall Broom-rape

This species reaches its easternmost area of distribution as a shoreline plant along the Lake Michigan dunes in Illinois and Indiana, north in Michigan to the Sleeping Bear dunes (Leelanau Co.) and Beaver Island. It is parasitic here on *Artemisia caudata,* but has



Map. 9. Distribution of *Bromus pumpellianus* in the Great Lakes region.

never been found with this species inland or on other of the Great Lakes, where the *Artemisia* occurs. In Illinois, its range extends inland to a widespread western distribution.

IV. NORTHERN SPECIES

Selaginella selaginoides (Linnaeus) Link Northern Spikemoss

Found from Greenland and Labrador to Alaska, this boreal species comes south in the Great Lakes region to Michigan (mapped by McVaugh, 1953, p. 290); the north shore of Lake Superior, Manitoulin Island, and the Bruce Peninsula in Ontario; and the Door Peninsula in Wisconsin. It is found normally in mossy, often shaded sites on rocky shores and frequently somewhat calcareous beachpool hummocks. It is known from one somewhat inland location in Michigan: sandy bog east of Shingleton, Alger Co. (*Nichols* in 1936, UMBS). Hultén (1958, p. 241) maps its total distribution, including Europe and Asia.

Parnassia parviflora DeCandolle Grass-of-Parnasus

In our region, the small-flowered grass-of-parnassus seems restricted to wet flats and beach meadows along Lakes Superior, Michigan, and Huron. It ranges northward from Labrador to Alaska, and is reported southward in the west to Utah and New Mexico.

Anemone multifida Poiret Red Windflower

MAP 10. Around the northern portions of Lakes Huron and Michigan, and northeastern Lake Superior, this anemone is typical of sandy shores and dunes along with the most restricted of the sandy shoreline species. However, it occurs more on rock in the northwestern Lake Superior region and throughout its major range from Newfoundland to Hudson Bay and Alaska and at higher elevations in the west. In addition, it occurs in southern South America, whence it was originally described. Its apparent absence from the south shore of Lake Superior is striking.

Primula mistassinica Michaux Birds-eye Primrose

Extending across the continent in the north from Labrador to Alaska, *P. mistassinica* (including *P. intercedens*) extends southward along the shores of Lakes Superior, Michigan, and Huron, with more inland localities in the southern portion of its range than the species previously mentioned. There are inland locations, mostly in calcareous boggy habitats, in Michigan (see Voss, 1957, p. 94) and also in New York, Illinois, Wisconsin, and Iowa. Often associated with the next species in rock crevices in the Lake Superior region, *P. mistassinica* is characteristic of marly beach flats and meadows along the northern shores of Lakes Michigan and Huron.

Pinguicula vulgaris Linnaeus Butterwort

A widespread northern species, like the preceding (but also in Eurasia), and found in similar habitats, but not extending so far south in the Great Lakes region. The total distribution is shown by Hultén (1958, p. 231).

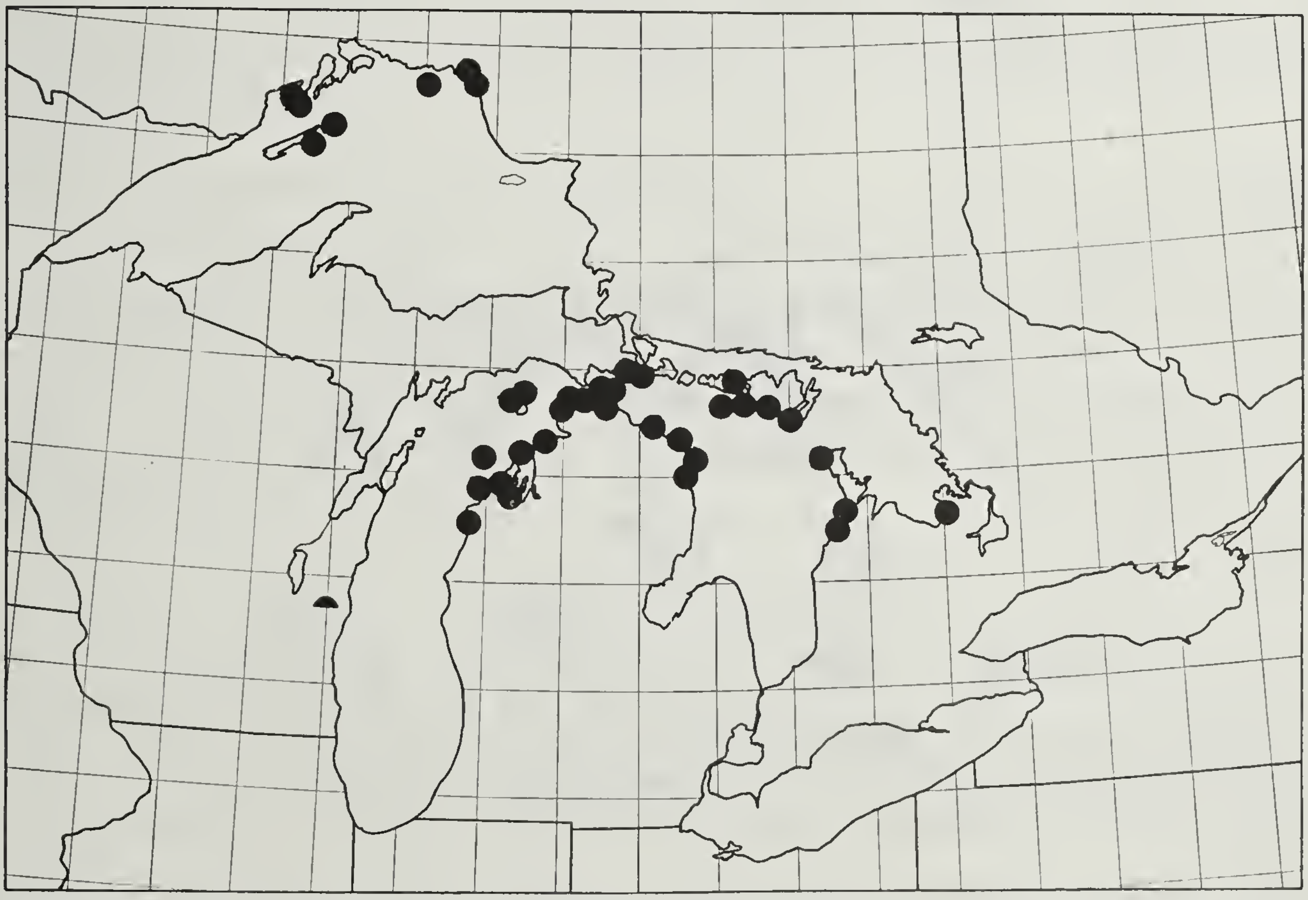
NOTE: At this point in our series of "Northern Species," many additional northern species could be added which only come as far south as the shore of Lake Superior. Maps of several of these (*Woodsia alpina, Trisetum spicatum* var. *pilosiglume*, *Polygonum viviparum*, *Sagina nodosa*, and *Saxifraga aizoön*) in the Lake Superior — Hudson Bay region are given by Soper and Maycock (1963). Species such as these, which are basically northern and do not even come as far south as the sandy southeast shores of Lake Superior, are not here treated as noteworthy shoreline species.

V. MISCELLANEOUS DISTRIBUTIONS

There are a number of other species which are often considered to be characteristic shoreline species of the Great Lakes, but which in actuality have less restricted distributions than those treated above, or at least do not fall readily into the above distribution patterns. We present notes on some of the more striking of these, for which less full data have been gathered, to call attention not only to their frequency on shorelines but also to their occurrence elsewhere. These will merit further phytogeographic study.

Hypericum kalmianum Linnaeus Kalm's St. Johnswort

MAP 11. While the total distribution of this attractive shrubby species is limited to the general Great Lakes region, and it is often



Map. 10. Distribution of *Anemone multifida* in the Great Lakes region.

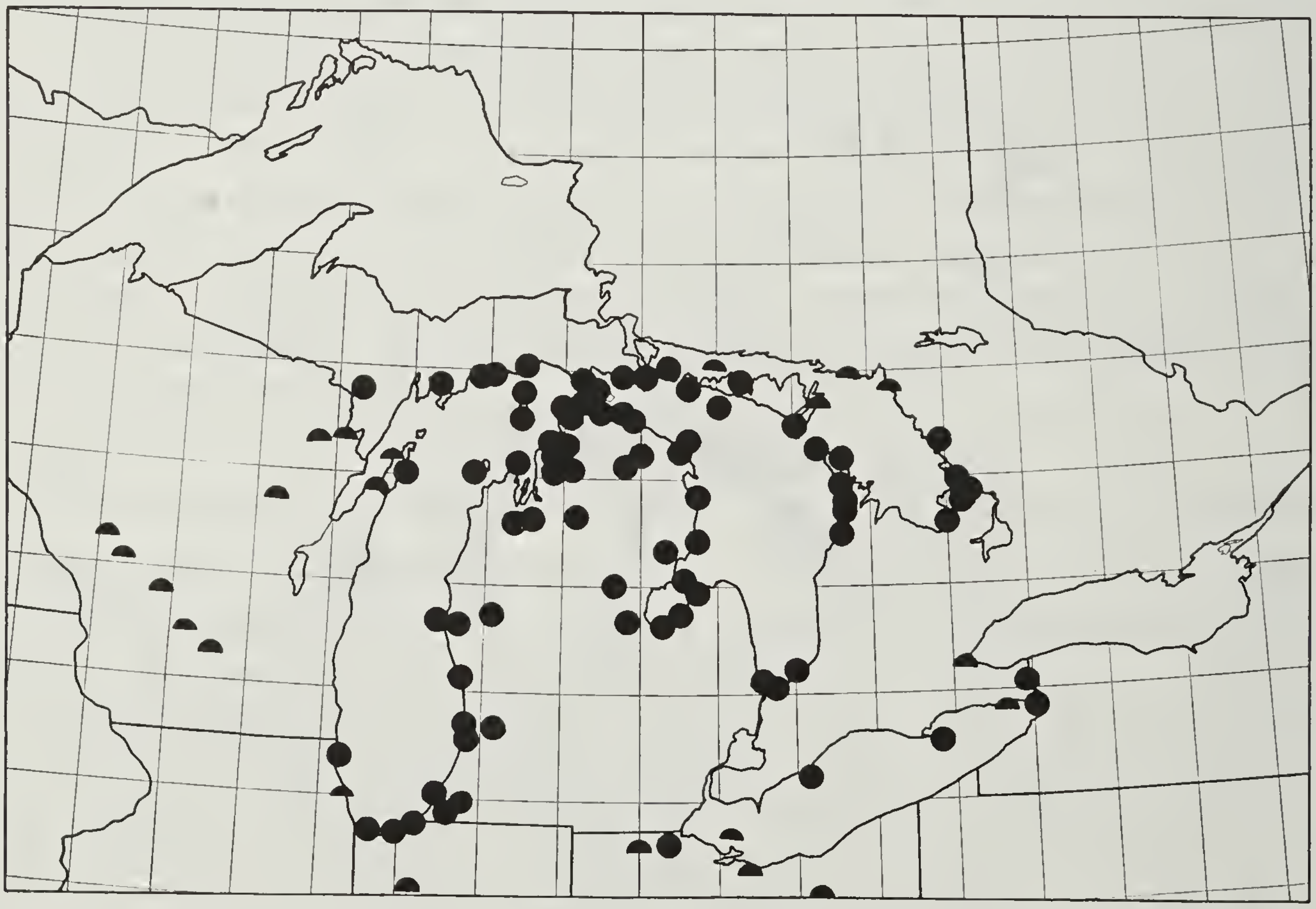
cited as nearly or exclusively a beach plant, it is known from many inland locations, a few of which are beyond the boundaries of our map. As long ago as 1899, E. J. Hill called attention to the need for better knowledge of the distribution of this species, which was first collected by Peter Kalm—presumably at Niagara Falls, since that is the only site now known for the species which Kalm reached in his travels.

Salix cordata Michaux Sand Dune Willow

Fernald segregated the Great Lakes dune and beach plants as a separate species, *S. syrticola,* which, if recognized, would belong with the first three endemic species above (type locality: sandy shores of Lake Michigan, near Chicago). However, following such *Salix* authorities as Raup and Ball, who include these plants with the more widespread *S. cordata,* we have a species ranging on shores from Newfoundland to Hudson Bay, south to Maine and the Great Lakes. In our region, the only inland location is (like *Ammophila*) the shore of Douglas Lake (*Gates 8675,* and others, UMBS).

Salix glaucophylloides Fernald Dune Willow

Similar to *S. cordata* in its overall range, this willow is more frequently found inland, although still primarily a shore species. It is often found growing with the preceding, and the two probably hybridize. Fernald's treatment of this species includes two varieties endemic about the Great Lakes, but in this he is not followed by Ball.



Map. 11. Distribution of *Hypericum kalmianum* in the Great Lakes region.

Juniperus horizontalis Moench Prostrate Juniper

A plant of sandy shores and dunes in the Great Lakes region, this shrub also occurs along the Atlantic coast, and westward to Wyoming and Yukon (see map in Fassett, 1945, p. 481).

Hudsonia tomentosa Nuttall Beach-heath

A plant of sandy habitats along shores (especially the south shore of Lake Superior) and rarely inland in the Great Lakes region, ranging from Quebec to North Carolina and West Virginia and westward to Alberta and northern Illinois.

Carex crawei Dewey

Although this species is found far to the east, west, and south of the Great Lakes in calcareous and rocky areas, in this region it is reasonably restricted to the shores of the Great Lakes, exactly as stated by Hermann (1941, p. 43), who also indicated its total distribution (p. 44). Raymond (1953, p. 92) maps the distribution of the species, but misinterprets Hermann's true statement that in the Lower Peninsula of Michigan it occurs chiefly on the shores of the Great Lakes.

Carex garberi Fernald

This sedge is often found in similar habitats to those of *C. crawei.* Its overall distribution differs, however, in that the typical variety is more closely restricted to the Great Lakes, but is not entirely a shoreline plant. The var. *bifaria* includes eastern and western populations. Both varieties are shown on a map by Fernald (1935, p. 255), to which additional dots could be added (most of those for Michigan are in Hermann, 1941, p. 85).

Satureja arkansana (Nuttall) Briquet Calamint

This strongly odorous mint (also known as *Calamintha glabella* var. *angustifolia*) is found on rocky and gravelly calcareous shores in the northern parts of Lakes Huron and Michigan (see map in Waterman, 1960, p. 293, for Michigan locations; Koeppen, 1957, p. 133, for Wisconsin). However, it is also distributed south and southwest of the Lakes region, to Texas.

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STRIKING FEATURES IN THE DEVELOPMENT OF INTERNODAL EPIDERMIS IN THE OAT PLANT (*AVENA SATIVA*)

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One of the most fascinating experiences in biology is to examine the surfaces of plants either with a hand lens or the dissecting microscope. In this brief account, we describe some of the more interesting features of the epidermal system in internodes of the oat plant (*Avena sativa* L.) during its course of development, using the epidermal peel technique.

Avena sativa, a member of the Aveneae tribe of the grass family (Gramineae), is widely cultivated in Michigan and elsewhere, and in turn, it often escapes and is commonly found in waste places. It was introduced into Eastern U. S. from Eurasia. The plants that were employed in this study were grown at the University of Michigan Botanical Gardens, and representative cultures of *Avena sativa* and other species of *Avena* can be found in the permanent Systematics Collection of Grasses outdoors at the Botanical Gardens. The oat plant is of considerable economic importance; it is widely employed as a feed and is used in preparation of cereals. It is also used as an ornamental in dried arrangements.

We chose to investigate the internodal epidermis in the oat plant, after extensive studies of a similar nature on rice (*Oryza sativa* L.), primarily in connection with our efforts to learn more about the development of grass internodes and the underlying mechanism of stem elongation in grasses. The epidermis is botanically important for several reasons: (1) it has been widely used by taxonomists in a more definitive separation of the various tribes of the grass family; (2) it shows a diverse array of specialized cell types (stomates, hairs, cork and silica cells, and long epidermal cells) that can be used to demonstrate, beautifully, cell differentiation; (3) it illustrates, just as well as root tips, the various stages of mitosis—here in the intercalary meristem zone (a site of cell division and enlargement that occurs at the base of the internode) — using the epidermal peel technique that we have described below; and (4) it can be used by students to study growth, growth rates, and distribution of growth in the stem simply by removing the sheath surrounding one of the internodes (best to choose one that has just started elongating), marking it with india ink or dusting it with carbon black or even *Lycopodium* spores, and growing the excised shoot portion containing the internode in the dark in a glass tube (an "artificial sheath") inserted in a test tube containing 1.5 milliliters of 5% sugar solution.

METHODS OF OBTAINING PEELS

The epidermis of *Avena* is one cell layer thick. By making a slight incision in the internode with a razor blade, and grasping the loose flap of epidermis with a pair of forceps, we were able to pull off a single layer sheet of epidermal cells (some as long as the entire internode); this sheet of epidermal cells is called a peel.

Epidermal peels were prepared from internodes in order to determine the size and number of cells in typical vertical cell files; number and location of idioblasts (specialized types of cells in the epidermis); and number, stage, and distribution of mitoses.

Shoots[1] with internodes of contrasting lengths and ages were selected to show the various developmental stages of the internodes. In order to obtain peels of the entire length of the internode, we scored the epidermis at about 6 mm. intervals and took peels of these scored sections. These peels were then designated as basal, middle, and apical. They were immediately placed in water to prevent drying and curling, then stained on a slide in a drop of freshly prepared acetocarmine. Slides were stored in the refrigerator at 4°C. except during periods of microscopic examination.

Cells were counted and measured in two full-length epidermal files from each internode. One of these files included a row of stomates alternating with long epidermal cells. The other file consisted of a row of cork and silica cell pairs alternating with long epidermal cells.

The internode which we have examined most critically is the next to the last one in the shoot, directly below the peduncular node. We shall designate this as $p\text{-}1^i$.

DEVELOPMENT OF SPECIALIZED CELLS IN THE EPIDERMIS OF *AVENA* STEMS

The epidermis of *Avena* has several interesting kinds of cells that are initiated along the entire length of extremely young internodes (less than 2 mm. long), and later, at the base of the internode in an intercalary meristem zone. These epidermal cells include (1) pairs of cork and silica cells (short cells), (2) long epidermal cells which alternate either with pairs of cork and silica cells or with (3) stomates and their associated subsidiary cells, and (4) hairs (trichomes), which develop from single short cells. The initiation and development of these specialized cells (idioblasts) is described below.

If we make epidermal peels from $p\text{-}1^i$ of *Avena* when the internode is 6 to 8 mm. long, many of the different stages of mitosis can be observed in the basal-most cells of the intercalary meristem (Fig. 1).

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[1] Derived from cultures of *Avena sativa* cv. "Clinton" grown in greenhouse (mean day temp. 26.5°C., 22°C. mean night temp.) at University of Michigan Botanical Gardens.

Just above the nodal plate, the epidermal cells are quite short (20 to 25 microns long), essentially isodiametric, and of similar size. Immediately above this zone, alternating pairs of long and short cells can be detected. This means that morphologic differentiation of the specialized epidermal cells begins to occur early and in close proximity to the base of the internode. The shorter cells are initials of pairs of cork and silica cells, stomates or trichomes. In development of pairs of cork and silica cells (Figs. 2, 4a), the short cell initial divides once in a plane perpendicular to the axis of the internode; the upper cell will become a silica cell, the basal one a cork cell. The cork cell retains its protoplast, whilst the silica cell protoplast degenerates and both wall and lumen become filled with silica. Occasionally, the initial fails to divide. It usually then develops into a silica cell or a trichome.

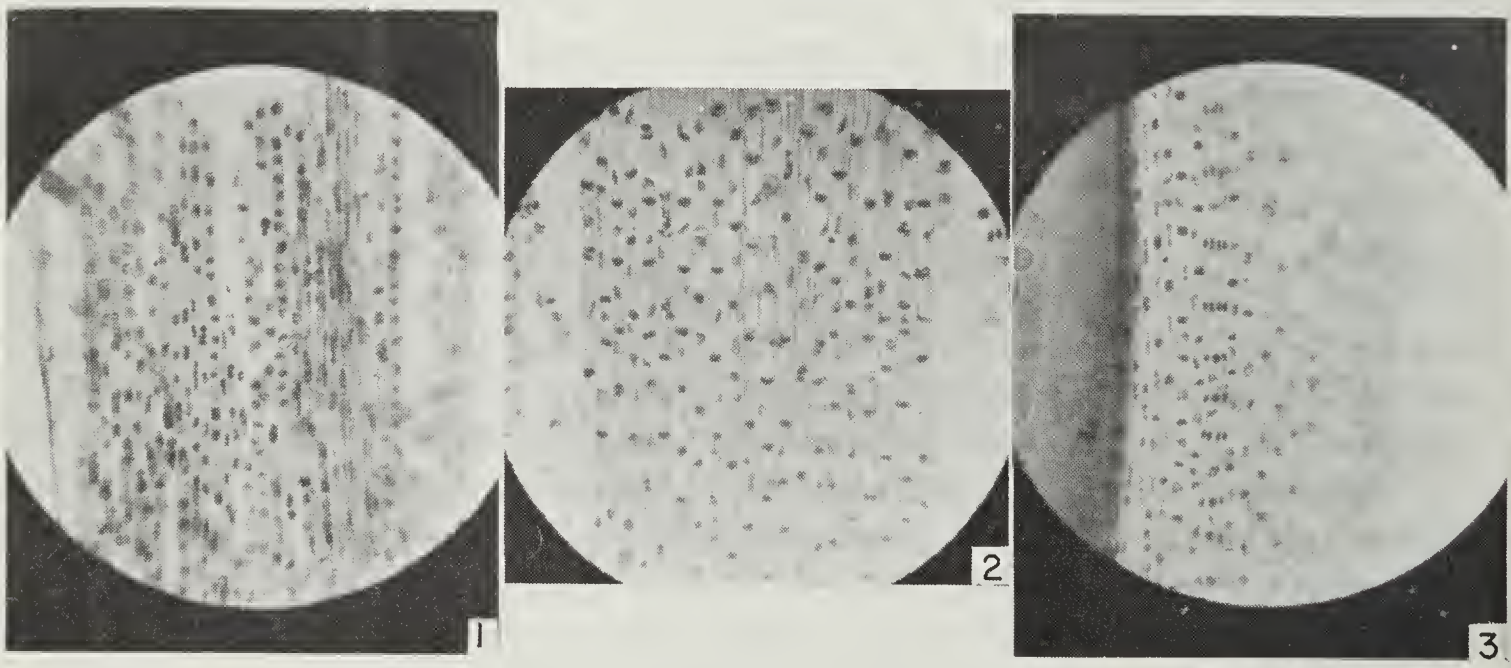
The development of stomates is more complex (Fig. 4b). In short cell initials, which are destined to become stomates, first one cell is cut off laterally, then another on the opposite side of the initial. These are the future subsidiary cells. The center cell is called a guard cell mother cell initial (Fig. 3). It divides once again in a plane parallel to the long axis of the internode to form two guard cells (also, Fig. 3). This developmental sequence for stomates has been thoroughly described for grasses (Bonnett, 1961; Flint and Moreland, 1946; Kaufman, 1959; Porterfield, 1937). It is particularly noteworthy that this *kind* of sequence, characteristic of the entire grass family and the sedge family (Cyperaceae) has not been described for any of the other plant families. The stomates are initiated earlier and at lower levels than the pairs of cork and silica cells. What determines whether a short cell initial will become a silica cell, a trichome, or a pair of cork and silica cells, or a stomate is still an unsolved problem. The fact that cells in the intercalary meristem zone become alternating long and short cell initials suggests that there must be some underlying genetically controlled mechanism which determines this remarkable ordered arrangement of cells.

The alternating long cells (30 to 40 microns in length) at the base of the internode elongate quite significantly. In fact, at maturity, some are as long as 860 microns (0.86 mm.), meaning a 20 to 30-fold increase in length during extension growth of the internode. This accounts for most of the extension growth that occurs in long internodes of grasses. However, some of this increase in length can be attributed to increase in cell number, which initially is substantial, then tapers off subtly (Fig. 5). The *later* addition of new cells occurs almost exclusively in the intercalary meristem zone at the base of the internode. All of the above developmental sequences in both long and short cells takes place in a zone extending from just above the nodal plate to a distance of about 1 to 1.5 cm. above this plate (unpublished data). The characteristic fully-differentiated cells of the epidermal system are described and illustrated in the next section. Artschwager (1930) and Prat (1935) have treated the structure of the epidermal system in other grasses in considerable detail.

THE BIZARRE STRUCTURE OF THE FULLY-DIFFERENTIATED EPIDERMIS IN *AVENA* INTERNODES

For the sake of convenience, we shall examine the epidermal system in a mature internode, p-1[1], of *Avena* from the peduncular node to the base of the internode. The mean length of this internode is 12 cm. in the cultivar, "Clinton," which we employed.

Just *below* the nodal plate of the peduncular node, stomates and pairs of silica and cork cells occur with greater frequency than in lower positions of the internode, and the epidermal cells are much shorter (Fig. 6). The latter have striking undulating longitudinal walls. Epidermal cells in this position of the internode differentiate earlier than those below; apparently cell elongation in these cells must be of shorter duration than in long epidermal cells in lower positions. Other long epidermal cells *just below* this zone are, in fact, much longer. These and the shorter long epidermal cells above vary in length between 60 and 524 μ (mean length = 223.3 μ).



Figs. 1-3. Photomicrographs of epidermal peels, depicting several stages in the development of the epidermal system in p-1 internode of *Avena sativa*. Fig. 1. Intercalary meristem at base of p-1 internode where incipient stages of differentiation of epidermal system into long and short cells can be seen. Fig. 2. Portion of epidermal system where pairs of cork and silica cells are developing from short cell initials that alternate with long epidermal cells. Fig. 3. Series of long and short epidermal cells at locus where guard cell mother cells are forming pairs of guard cells; subsidiary cells of the stomatal apparatus are located on either side of this mother cell or the pair of young guard cells. All × 550. Length of p-1 internode used for each peel is 0.8 cm. (Figs. 1-3).

In the *middle* of p-1^{i}, the entire array of epidermal idioblasts can be observed. These include pairs of cork and silica cells, series of stomates alternating with relatively long epidermal cells (80 - 614 μ; mean length - 428 μ), and occasional trichomes (Fig. 7).

In the *basal* portion of p-1^{i}, pairs of cork and silica cells are *absent.* Thus, we see only long epidermal cells, the characteristic series of stomates, and trichomes. Here, the long epidermal cells vary between 116 and 860 μ in length (mean length - 523.5 μ). It is in this region, the site of the intercalary meristem (Fig. 8), where the greatest amount of cell elongation takes place as evidenced by the above figures for lengths of long epidermal cells. Why no pairs of cork and silica cells are formed by the intercalary meristem during its terminal stage of mitotic activity in the basal portion of the internode, and *are* formed earlier, is a provocative morphogenetic question that awaits further study.

Our studies are continuing on internodal epidermis in other genera of grasses. We are interested in the apparently unique occurrence of spiral nuclei in long cells in the bases of grass internodal epidermal cells. We are also making an extensive reconnaissance survey of frequency of mitoses, cell size and number, and frequency of occurrence of epidermal idioblasts in grass internodes at different stages of development. And finally, we are probing into some of the causal mechanisms which might explain these interesting developmental patterns in internodal epidermis of grasses.

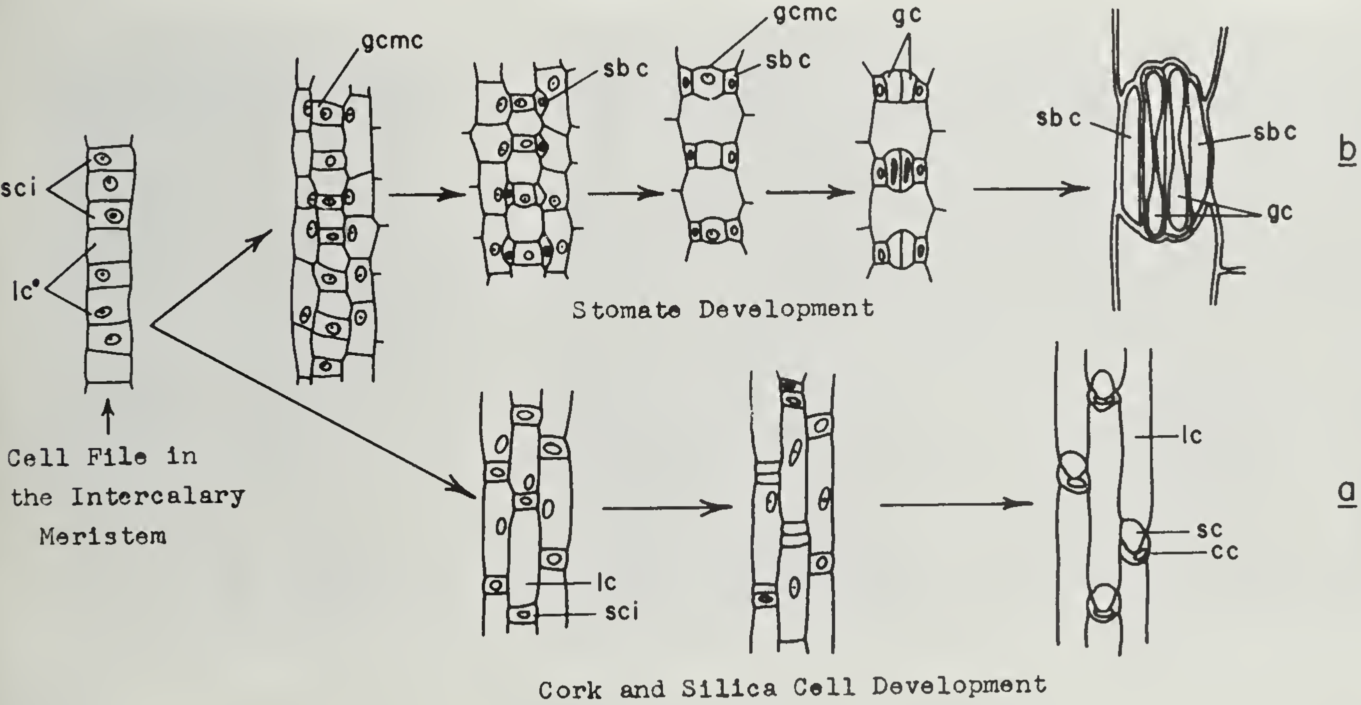


Fig. 4. Diagrams illustrating the development of a series of cork and silica cells (*a*) and a series of stomates (*b*) from a linear file of cells (far left diagram) in the intercalary meristem zone at the base of the internode. File of cells at far left is equivalent to the center file of cells in diagrams where three series of cells are shown. lc^{o} = long cell before elongation has occurred; lc = long cell; sci = silica and cork cell initial; sc = silica cell; cc = cork cell; gcmc = guard cell mother cell initial; sb c = subsidiary cell; gc = guard cell.

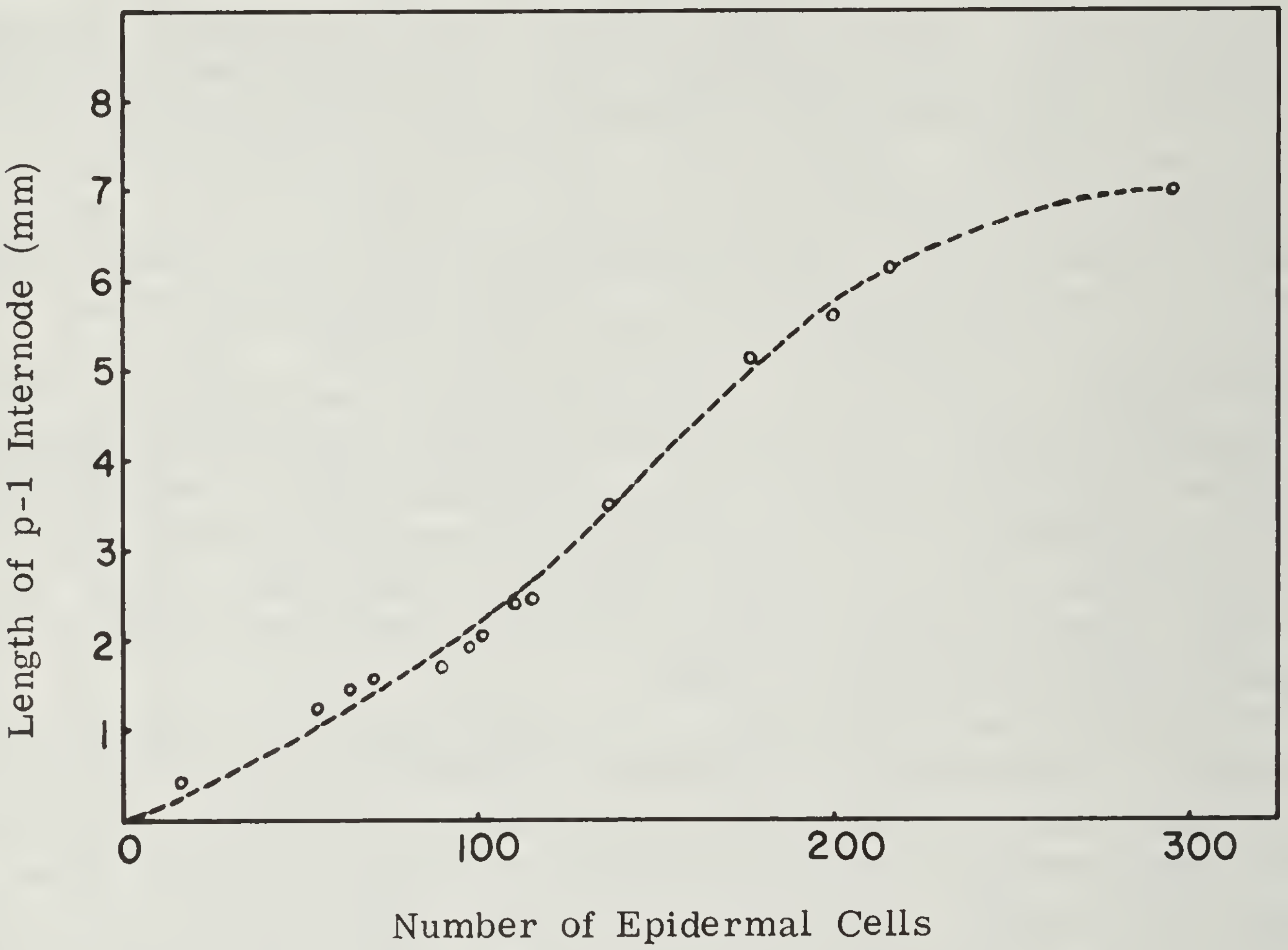
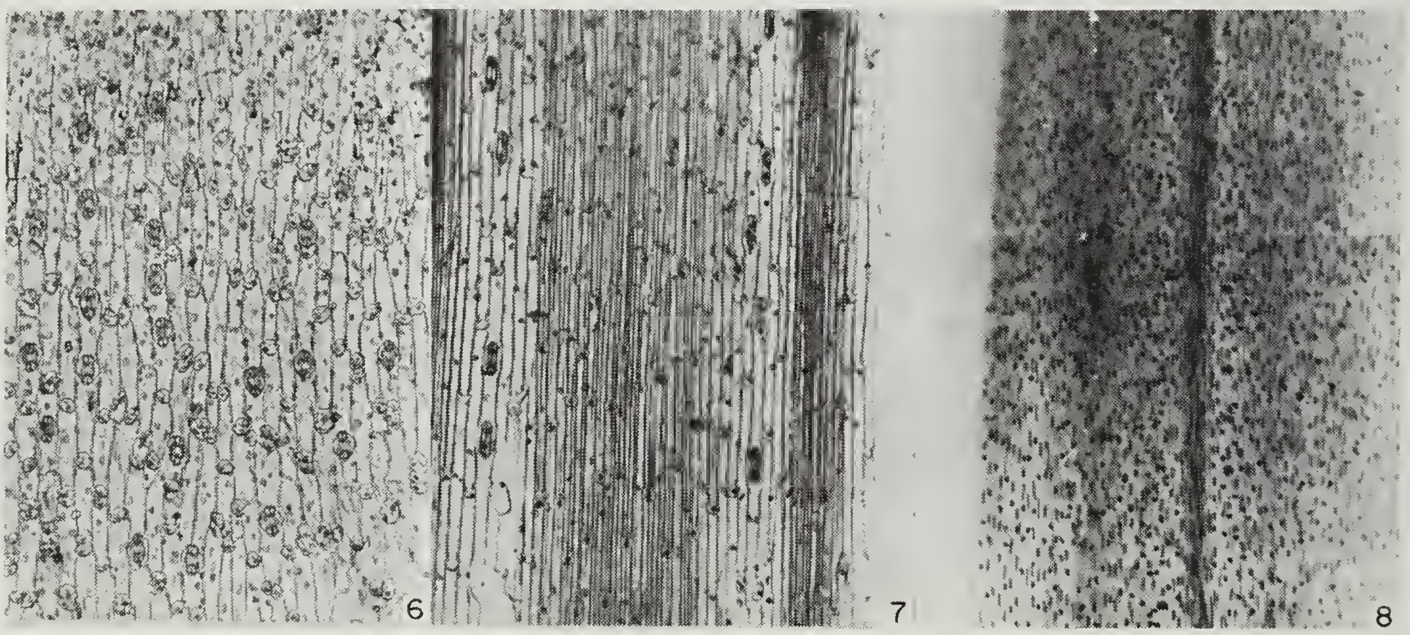


Fig. 5. Number of epidermal cells in a single cell file in p-1 internode of *Avena sativa* cv. "Clinton" at different stages of development. Counts were made from the base of p-1 internode to the apex of this internode, using a single and continuous file of epidermal cells in median longitudinal sections of the internode.



Figs. 6-8. Photomicrographs of epidermal peels, illustrating fully-differentiated epidermal system at top of p-1 internode in *Avena sativa* (Fig. 6), middle portion of the epidermal system where occasional stomates and pairs of cork and silica cells can be seen (Fig. 7), and basal portion of the internode at the site of a still active intercalary meristem, where extremely long nuclei and spiral nuclei in future long epidermal cells can be observed (Fig. 8). All ×110. Lengths of p-1 internodes used for peels are 1.2 cm. (Fig. 6), 2.1 cm. (Fig. 7), and 4.7 cm. (Fig. 8).

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THE INFLUENCE OF DEFOLIATION OF DISEASED AMERICAN ELMS ON THE VERTICAL GROWTH OF VINES

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Defoliation of American elms (*Ulmus americana* L.) owing to Dutch elm disease affords an opportunity to investigate the possible effects of increased illumination on the growth of vines supported by the diseased trees. To my knowledge no quantitative evaluations of this sort have been reported on in the literature. The field observations on which this report is based were made in early September, 1961, in Van Buren County, Michigan.

METHODS

A total of 51 trees supporting 57 vines of 4 species were examined. Trees were selected during an automobile drive along secondary roads in Van Buren County and a stop for observations was made at each elm tree that showed defoliation. Only those trees were selected for this study that were not shaded by adjacent trees, that were more than 20 feet tall, that were not completely defoliated, and that supported vines having a main-axis diameter exceeding 3/8 inch at a height of 5 feet. Heights of tree and supported vine were determined using a split-image range finder. Transmission by the crown foliage of the tree of direct incoming solar radiation was measured with a photometer; light intensity in foot-candles reflected from an unshaded surface near the tree was compared with that reflected from a surface of the same albedo but shaded by the crown foliage of the particular tree. For analyses of heights using the entire sample, the relative height of the vine and the tree (H_v/H_t) was used inasmuch as the trees ranged in height from 25 to 110 feet. Analyses involving absolute heights of vines were limited to data obtained from trees 40 to 50 feet tall.

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RESULTS

Of the four species of vines included in this study, only Virginia creeper (*Parthenocissus quinquefolia* L.) and poison ivy (*Rhus radicans* L.) were encountered frequently enough to allow comparison with defoliation of the supporting trees. Wild grape (*Vitis* sp.) was found on only 4 trees and moonseed (*Menispermum canadense* L.) on one.

Elm trees supporting Virginia creeper had an average height of 47.4 ft. (range, 25-75); the mean height of the supported vines was 35.4 ft. (11-67). Trees supporting poison ivy had an average height of 49.4 ft. (30-110) and the poison ivy vines averaged 22.3 ft. in height (5-45). Mean transmission of total light through the crown of elms supporting Virginia creeper was 55 percent; that for elms supporting poison ivy was 67 percent.

The relative height of both species of vines increased as defoliation of elms and, consequently, illumination increased (Fig. 1). Poison ivy, however, seemingly is not affected by increased defoliation of elms to the same degree as is Virginia creeper, with this difference being particularly noticeable when both species of vines were encountered on the same tree (Table 1).

Table 1. Comparison of heights (in feet) of two species of vines where they occurred on the same elm tree.

Height of supporting tree	Height of vines *Rhus*	 *Parthenocissus*	Light transmission by crown
50	23	45	87%
50	15	40	85%
45	20	35	42%
40	15	25	20%

Comparison of absolute height of vines with illumination indicates that there may also be a relationship between actual vertical increment and the amount of light to which the vines are exposed. Elms that had only recently been damaged by Dutch elm disease and whose crown foliage was still relatively intact (only 40-50% of the available incoming light was transmitted through the crown) supported poison ivy having a mean height of 15 feet, whereas elms with the same degree of defoliation supported Virginia creeper vines having a mean height of 32 feet. Considering trees in which defoliation was more advanced (80-90% transmission of available incoming light) the mean height of poison ivy was 27 feet and that of Virginia creeper was 40 feet. These data suggest that poison ivy increases in height more rapidly than does Virginia creeper under similar environmental conditions.

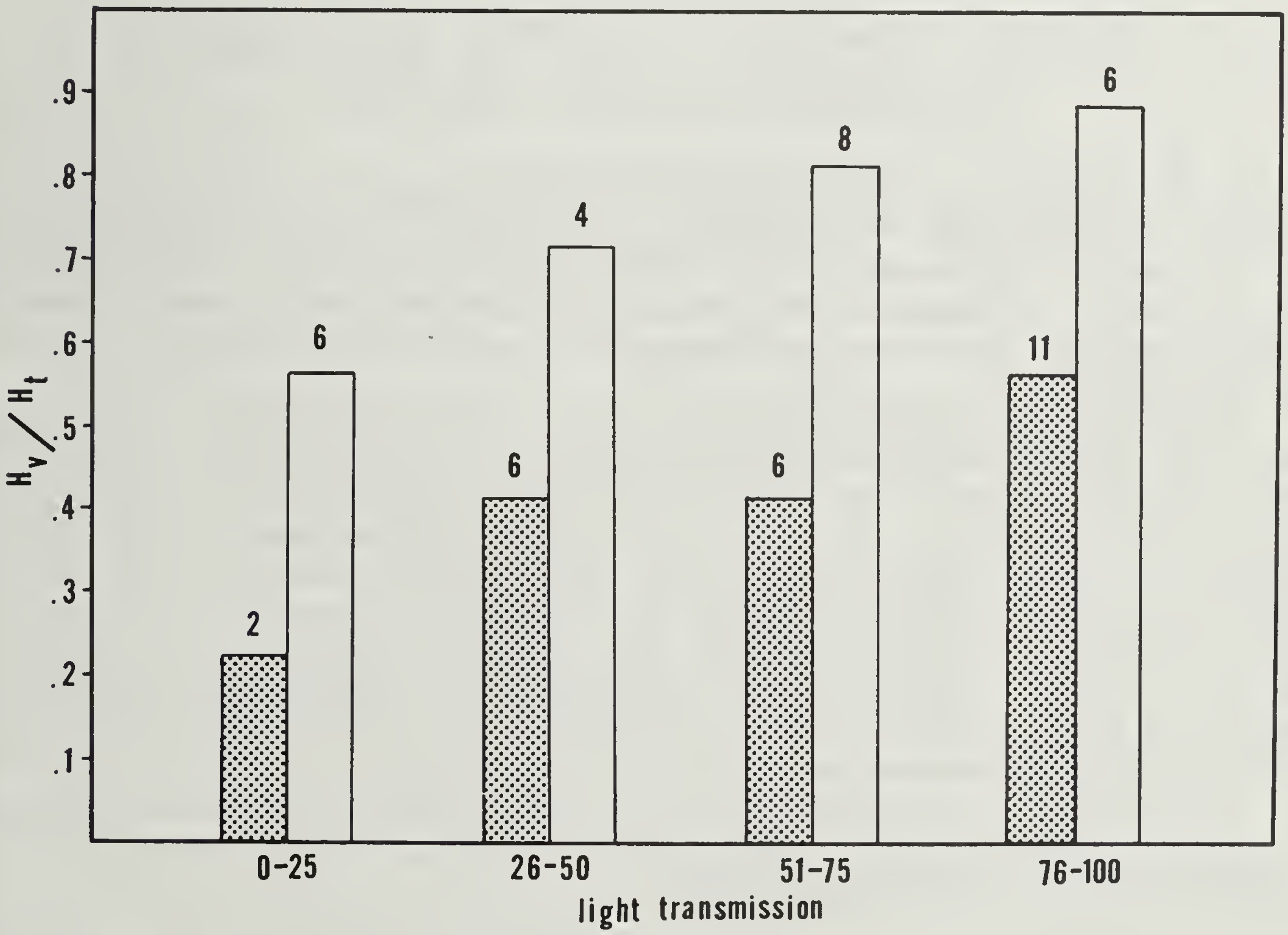

Fig. 1. Comparison of mean relative height of vine and tree (H_v/H_t) and light transmission by tree crown (in percent of total possible illumination). Stippled bars, poison ivy; open bars, Virginia creeper. Numbers above bars indicate number of trees in sample.

CONCLUSIONS

A positive correlation exists between illumination beneath the crown foliage of isolated American elms and both relative and absolute heights of attached poison ivy and Virginia creeper in southwestern Michigan. Although poison ivy seems to grow more rapidly than does Virginia creeper, the former species does not attain the height that Virginia creeper does. This difference in height may be because Virginia creeper is more tolerant to shading than is poison ivy, thus allowing Virginia creeper to attain a greater height than poison ivy prior to defoliation by Dutch elm disease.

American Chestnut, an Addition to the Flora of Kalamazoo County, Michigan

In the excellent treatment of the vascular plants of Kalamazoo County, Michigan, by Hanes and Hanes (1947),[1] the family Fagaceae is represented by only two genera, *Fagus* and *Quercus*. The American chestnut, *Castanea dentata* (Marsh.) Borkh., although known to occur in southern Michigan, was not included by them, and this species is not represented in the Hanes Herbarium, Western Michigan University.

In the autumn of 1961 the writer and W. C. Van Deventer, while walking along an old logging trail at the edge of a *Sphagnum* bog (NW¼, Sec. 15, T2S, R12W, Kalamazoo Quadrangle), found a small (1.4 meters tall) specimen of this species growing next the trail. In the spring of 1962 the specimen was transplanted carefully to a more protected site, where it is thriving at the time of this writing, ½ mile east of its original location. We searched diligently the vicinity of the specimen for other individuals of the same species; this search and subsequent ones by the writer were fruitless. At the time of transplanting, the small tree was found to be attached to a rootstock of larger diameter than the above-ground portion of the stem, but no arent stump could be found.

I am indebted to Richard Brewer for bringing to my attention this omission from the list of plants for Kalamazoo County, and to L. C. VanderBeek for allowing me access to the Hanes Herbarium.

—Thane S. Robinson, Department of Biology,
Western Michigan University, Kalamazoo

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[1] Clarence R. Hanes & Florence N. Hanes, Flora of Kalamazoo County, Michigan. Vascular Plants. Schoolcraft, Michigan, 1947. xii + 295 pp.

THE SILICA GEL METHOD FOR DRYING MUSHROOMS

Florence V. Hoseney
University Herbarium, The University of Michigan

Mushrooms and other fleshy fungi to be prepared as herbarium specimens are ordinarily put in a hot-air drier. This method has certain disadvantages. Small, delicate fungi usually shrivel completely out of their recognizable shape. Other fungi such as the boletes sometimes have insect larvae in them which live on the fungous tissue and destroy it before the specimen is dry or the insect larvae are destroyed by the heat. The method proposed here, based on the use of silica gel, eliminates these disadvantages almost completely and presents a few advantages in turn.

To dry the mushroom specimens by this method, simply put them in a large-mouth container on a layer of silica gel crystals. Pour more crystals around and over them. Avoid crowding the specimens. In this way they can dry quickly, usually overnight. Plastic freezer containers with air-tight lids are satisfactory for small specimens. When removing the specimens, pour off the crystals slowly and carefully. Shake or brush out all adhering particles of silica gel.

Fragile mushrooms dried in this way keep their shape well because they are buried in the crystals. Insect damage is no longer a problem because heat, which stimulates larval activity, is not needed and most insects are immediately dehydrated. On field trips, the more fragile specimens may be put directly into the crystals, thereby protecting them from breakage or deterioration, provided they are not jostled unduly. This is a particularly fine method for collecting the smaller species of *Coprinus* and obtaining good herbarium specimens.

Silica gel is a chemically inactive crystalline compound which absorbs water rapidly, removing it from the atmosphere or any moist object in close proximity. It can be obtained from chemical supply dealers for approximately twelve dollars for five pounds. The crystals are made in several sizes. The smallest, 28-200 mesh, is recommended for most mushrooms. Removing these fine particles from the dried mushrooms, however, does take time and care. A larger size, 14-20 mesh, is satisfactory, but the crystals tend to become lodged between the gills. Sticky fungi, or those without gills, should be dried with the larger crystals.

Silica gel is white and does not change in appearance as water is absorbed. It should be mixed with indicator crystals which are blue but turn pink when saturated with water. A good ratio is five parts of the white silica gel to one part of the blue crystals. When the blue to pink color change has occurred, the crystals can be dried by spreading them out in a wide shallow pan and placing them in an oven at 250°F for 30 minutes, or until the indicating crystals are bright blue again. The temperature should not be allowed to exceed 300°F. Thus silica gel can be used over and over, indefinitely. It should always be kept in air-tight containers, while in use or in storage, to avoid absorption of water from the air.

Silica gel is used commercially for keeping packaged foods such as potato chips dry and crisp. It is used also for drying flowers for winter bouquets. Flowers dried in this way retain most of their color. Persons who wish to dry some of the more beautiful mushrooms for flower arrangements will especially welcome this technique.

Many kinds of mushrooms have been dried in the course of experimenting with this method, among them: *Mycena, Panaeolus, Conocybe, Coprinus, Pseudocoprinus, Agaricus, Agrocybe, Boletus, Psathyrella, Morchella, Lactarius, Tricholoma, Gymnopilus, Helotium, Clavaria, Crepidotus, Hygrophorus, Rhodophyllus, Clitocybe, Ascotremella, Marasmius, Peziza, Laccaria, Amanita muscaria, Pholiota squarroso–adiposa, Pholiota spumosa, Flammulina velutipes,* and *Pseudohydnum gelatinosum.* Some very fragile *Pseudocoprinus disseminatus,* including the accompanying wood and moss, dried beautifully overnight. The jelly fungi *Ascotremella* and *Pseudohydnum gelatinosum* also dried very nicely. Even *Coprinus micaceus* that had started to deliquesce dried perfectly. The more fibrous and larger mushrooms such as *Agaricus, Boletus, Morchella,* and *Agrocybe* maintain their original shapes better when dried whole, but may take a few hours longer.

The amateur botanist of mycologist can benefit by using silica gel because he may easily preserve his mushrooms to examine at his leisure. Specimens which he plans to send away for identification can be prepared very efficiently. Dr. Alexander H. Smith affirms that tissues of fungi dried in this manner revive in the usual way when sectioned for laboratory study.

The silica gel method is simple, odorless, quick, and without litter or fire hazard.

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NOTICE TO LIBRARIANS, SUBSCRIBERS, & BINDERS

A cumulative index to volumes 1 through 3 of THE MICHIGAN BOTANIST will be issued at the conclusion of volume 3. It is anticipated that the three volumes will be a convenient unit to bind together, readily usable with a single index.

Errata

In addition to more obvious typographical errors, the following errata have been noted in Vol. 2, No. 3 (May, 1963):

p. 78, line 5 of text, for eastern read western
p. 82, line 15 from bottom, for complied read compiled
p. 86, line 12 from bottom, for plant read plank
p. 90, line 3, for 4-toothed read 3-toothed

Editorial Notes

Limitations of space have required omission of the listings of new literature ("Michigan Plants in Print") in this issue. Look for them in January. The editor will appreciate having items called to his attention which might otherwise be overlooked.

Please note that all orders for additional copies and back issues should be sent to the business and circulation manager (see page 98), not to the editor.

The previous number (Vol. II, No. 3), was mailed May 15, 1963.

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(On the cover: Calamovilfa longifolia *var.* magna, *a characteristic large-panicled dune grass of the Great Lakes. Photographed in Mackinac Co., Michigan, by E. G. Voss, August, 1963. See p. 106)*

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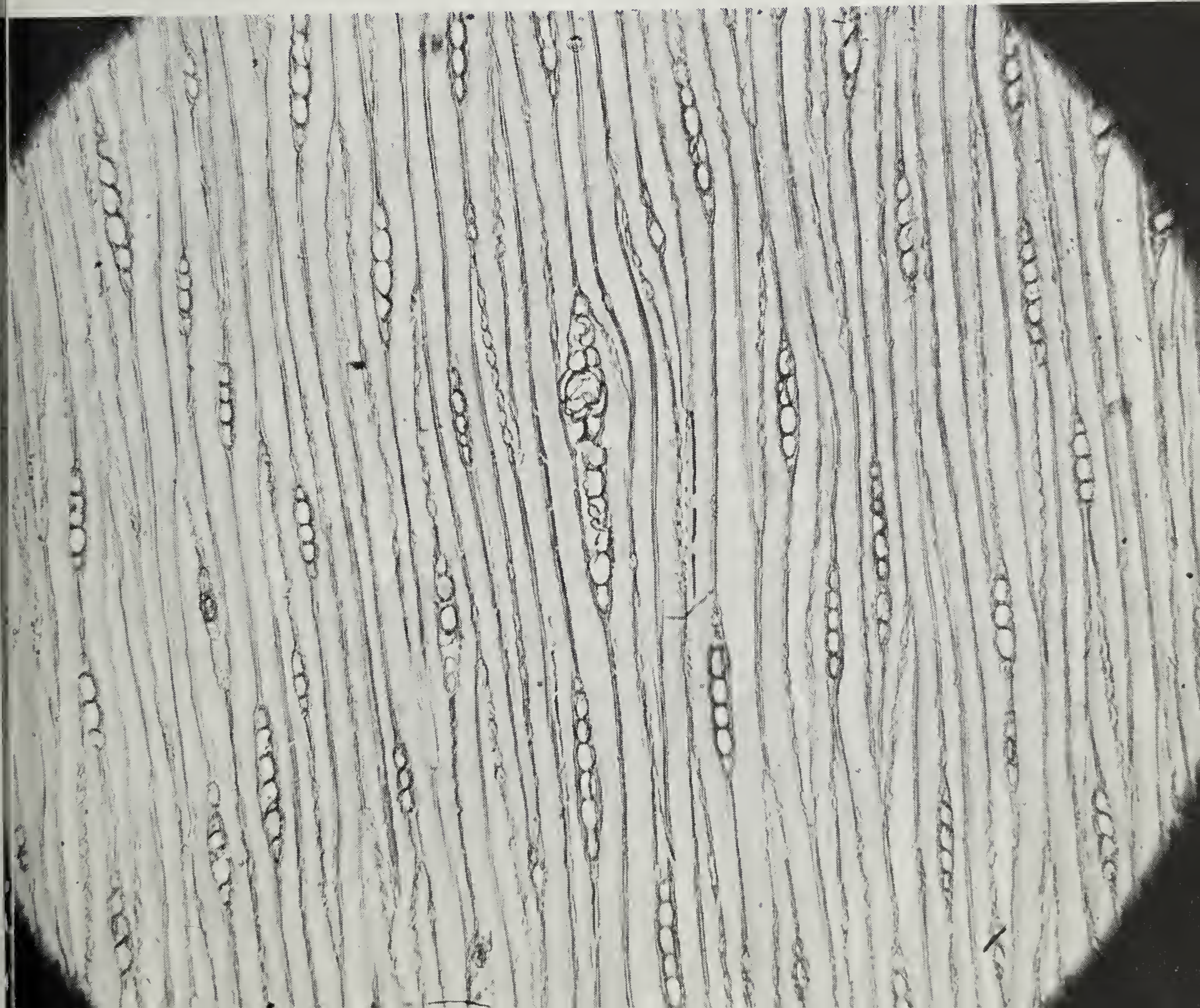

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Articles and notes relating to any phase of botany in the Upper Great Lakes region are welcomed; manuscripts should be sent to the editor in chief. Subscriptions and inquiries regarding them (from those not members of the Michigan Botanical Club) should be sent to the circulation manager, who will assume that subscriptions received prior to the last number of a volume are intended to begin with the first number of that volume unless specified to the contrary.

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THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora and to establish suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Inquiries regarding membership may be directed to the state secretary or, from those residing where there is a chapter, to the appropriate chapter secretary. (The Southeastern Chapter is centered in the Detroit metropolitan area; the Huron Valley Chapter, in Washtenaw County; and the Northwestern Chapter, in the northwestern Lower Peninsula.) Dues are modest, but vary slightly among the chapters; in all cases, they include subscription to THE MICHIGAN BOTANIST.

President: Charles Barclay, 915 Mixtwood, Ann Arbor, Michigan
Vice President: Virginia Bailey, 4727 Second Ave., Detroit 1, Michigan.
Secretary: Barbara L. Bowen, 1003 Brooks St., Ann Arbor, Michigan.
Treasurer: Charles Buswell, 19204 Plainview, Detroit 19, Michigan.
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Edith Brown, 5601 Bethel Church Road, Saline, Michigan
Secretary, Northwestern Chapter:
Donna Robinson, 411 N. Cedar, Traverse City, Michigan.

MOSSES OF THE DOUGLAS LAKE REGION OF MICHIGAN

Howard Crum
National Museum of Canada, Ottawa

Surely no area in North America has been so eagerly scoured for bryophytes as the Douglas Lake region of northern Michigan, and no other area has been so important in training a continuing supply of young bryologists. The course in bryology which George E. Nichols offered at the University of Michigan Biological Station from 1920 until his death in 1937 attracted good students from all over the country. It has continued in popularity and importance under the tutelage of William C. Steere, Margaret Fulford, A. J. Sharp, Paul M. Patterson, and the present author. This catalogue of 226 species, 17 varieties, and two forms of mosses is designed for the use of students at the Biological Station. Based on several years of careful, though intermittent, work, it is a fairly complete and accurate list of the mosses of Cheboygan, Emmet, Mackinac, and Presque Isle Counties. These counties, adjacent to the Straits of Mackinac, are the ones most easily and most often visited by students of the Biological Station.

Since so many students have collected in the Douglas Lake region over the past 43 years, every university herbarium in the United States probably has at least some mosses from there. It would be impossible to track down all such collections and confirm their identifications. I have picked up many records in an incidental fashion while studying in various herbaria. I have examined all the specimens in the Biological Station herbarium, sent on loan through the kindness of Dr. A. J. Sharp and Mr. Clem Bur, and in the fall of 1963 I spent two weeks in Ann Arbor, where I examined perhaps half of the many Douglas Lake specimens in the University of Michigan herbarium. I had already seen many other specimens which Mrs. R. R. Dieterle kindly and patiently sent on loan from the University herbarium; she also made available a number of interesting unnamed collections. I have greatly profited in examining collections made by Dr. Harold Robinson, Mr. S. J. Mazzer, and Mr. David G. Frodin when they were students at the Station. Dr. A. J. Sharp, Dr. Charles B. Arzeni, and Dr. H. T. Darlington have sent numerous interesting records and problem specimens. A few critical specimens from Nichols' herbarium at Yale University were lent by Dr. John R. Reeder.

I have made some attempt to confirm published records, but I found such a high percentage of error that it did not seem worthwhile to pursue that line of inquiry too far, particularly since most of the records were not cited specifically by number or date. The following papers include records from the area:

Nichols, G. E. 1922. The bryophytes of Michigan, with particular reference to the Douglas Lake region. Bryologist 25: 41-58.

———. 1925. *Ibid. II. Ibid.* 28: 73-75.

———. 1932. Notes on Michigan bryophytes. *Ibid.* 35: 5-8

———. 1933. *Ibid. II. Ibid.* 36: 69-78.

———. 1935. The bryophytes of Michigan with special reference to the Huron Mountain region. *Ibid.* 38: 11-19.

———, & W. C. Steere. 1936. Notes on Michigan bryophytes. III. *Ibid.* 39: 111-118.

Steere, W. C. 1934. Unreported or otherwise interesting bryophytes from Michigan. *Ibid.* 37: 59-62.

———. 1942. Notes on Michigan bryophytes. IV. *Ibid.* 45: 153-172.

Collectors cited in the catalogue by surname only are presented more fully in the following list:

LIST OF COLLECTORS

Ammons, Nelle
Apicos, Lucille
Arzeni, Charles B.
Banwell, Cecelia
Beach, Harriet
Benninghoff, W. S.
Berkeley, Laura H.
Bevis, Frederick B.
Blagg, Betty
Blanchard, Grace
Blinks, T.
Blum, John
Bohlen, Anne
Brask, Sannah A.
Brown, E.
Bryant, William
Chopra, Narinder
Clark, E.
Clark, G. T.
Clover, Elzada
Cobbe, Thomas J.
Crum, Howard A.
Deam, F.
Dieterle, Caroline
Drew, W. B.
Ehlers, J. H. & L. S.
Embree, Robert W.
Emmitt, Ronald W.
Feigley, Margaret D.
Forman, Richard T. T.
Frodin, David G.
Fulford, Margaret
Gambill, W. G.
Gates, Frank C.
Giesey, Robert M.
Gilly, Charles L.
Gleason, H. A., Jr.
Grant, Gertrude
Grassl, Carl O.
Harper, E. T. & Susan A.
Hatcher, Raymond E.
Hermann, Frederick J.
Hill, E. J.
Hubbard, John
Ikenberry, Gilford J.
Iltis, Hugh
Ireland, Robert R.
Iwatsuki, Zennoske
Johns, Robert
Kauffman, C. H.
Keck, Darvin
Koch, Leo F.
Kubsch, Flora
Lange, Bodil
Lange, Morten
Lawton, Elva
Lersten, Nels R.
Loveland, Hugh
Lowy, Bernard
Mazzer, S. J.
Mickel, John
Minert, Kay
Morrison, Barbara
Murchie, William
Nichols, George E.
Pagán, Francisco
Parmelee, G. W.
Patterson, Paul M.
Piehl, Martin
Phillips, Edwin A.
Phinney, H. K.
Pitelka, F. A.
Roberts, C. M.
Robertson, Marian R.
Robinson, Harold
Rogg, Ronald
Ropes, Marian
Sawyer, E.
Schneider, Curt R.
Schneider, M. J.
Schnooberger, Irma
Schuyler, A. E.
Shacklette, Hansford T.
Sharp, Aaron J.
Sharp, Evelyn
Shetler, Stanwyn G.
Sivon, Alta L.
Smith, Alexander H.
Steere, William C.
Sylva, Herman
Thomas, Paul
Tinney, F.
Wagoner, Evelyn
Walp, R. Lee
Wells, Elizebeath M.
Wells, James R.
Wetmore, Clifford M.
Wheeler, C. F.
Whitmire, Robert
Wood, Carroll E., Jr.
Woollett, M. L.
Wynne, Frances E.
Zwickey, A. L.

SPHAGNACEAE

Sphagnum magellanicum Brid. Cheboygan Co.: Reese's Bog (Frodin; Mazzer; Crum & Robinson); Iron Bridge, Carp Creek (Mazzer); Mud L. (Lange; Robinson). Emmet Co.: Stutsmanville (Robinson, Sharp, & Smith); French Farm L. (Robinson & Crum).

Sphagnum centrale C. Jens. Cheboygan Co.: Mud L. (Lange); Little Lake Sixteen (Crum).

Sphagnum papillosum Lindb. Cheboygan Co.: Mud L. (Robinson & Crum; Crum; Lange). Emmet Co.: Stutsmanville (Robinson).

Sphagnum palustre L. Cheboygan Co.: Gates' Bog (Schnooberger).

Sphagnum wulfianum Girg. Cheboygan Co.: Reese's Bog (Robinson; Crum; Robinson & Crum; Mazzer; Frodin); Hermits (Lange; Schnooberger); Gates' Bog (Schnooberger).

Sphagnum squarrosum Crome. Cheboygan Co.: Reese's Bog (Robinson; Crum); Carp Creek (Mazzer); Gorge of Carp Creek (Crum); Iron Bridge, Carp Creek (Robinson; Robinson & Crum; Frodin; Mazzer).

Sphagnum teres (Schimp.) Ångstr. Cheboygan Co.: Mud L. (Robinson; Robinson & Crum; Lange; Schnooberger).

Sphagnum recurvum P.-Beauv. Cheboygan Co.: Iron Bridge, Carp Creek (Mazzer); Gates' Bog (Schnooberger); Mud L. (Lange); Little Lake Sixteen (Crum). Emmet Co.: Stutsmanville (Robinson & Crum); French Farm L. (Crum & Robinson).

Sphagnum cuspidatum Ehrh. ex Hoffm. Cheboygan Co.: Mud L. (Robinson, Schuyler, & Bevis; Crum). Emmet Co.: Stutsmanville (Robinson; Lange).

Sphagnum dusenii C. Jens. ex Russ. Emmet Co.: French Farm L. (Robinson & Crum).

Sphagnum subsecundum Nees ex Sturm. Cheboygan Co.: Nichols' Bog (Apicos; Robinson & Crum). Mackinac Co.: Bois Blanc I. (Lange).

Sphagnum girgensohnii Russ. Cheboygan Co.: Reese's Bog (Robinson & Crum): Gorge of Carp Creek (Crum).

Sphagnum robustum (Russ.) Röll. Cheboygan Co.: Reese's Bog (Crum & Robinson).

Sphagnum fuscum (Schimp.) Klinggr. Cheboygan Co.: Reese's Bog (Robinson; Crum; Robinson & Crum); Iron Bridge, Carp Creek (Robinson & Mickel); Mud L. (Piehl; Lange). Emmet Co.: Cecil Bay (Robinson & Crum).

Sphagnum warnstorfianum DuRietz [*S. warnstorfii* Russ.] . Cheboygan Co.: Reese's Bog (Robinson); Mud L. (Lange). Emmet Co.: Cecil Bay (Robinson, Crum & Bevis).

Sphagnum capillaceum (Weiss) Schrank. Cheboygan Co.: Reese's Bog (Robinson & Mickel; Crum); Iron Bridge, Carp Creek (Robinson; Frodin); Mud L. (Robinson; Lange); Gates' Bog (Schnooberger). Emmet Co.: Stutsmanville (Robinson & Crum; Lange); French Farm L. (Robinson & Crum).—Var. *tenellum* (Schimp.) Andr. Cheboygan Co.: Reese's Bog (Crum); Mud L. (Robinson & Crum; Lange).

FISSIDENTACEAE

Fissidens grandifrons Brid. Attached to limestone rocks or pebbles and submerged in running water or springs. Cheboygan Co.: Mill Creek (Robinson & Crum; Wynne; Steere); Sturgeon R. (Deam; Bryant); Pigeon R. at Hwy. 68 (Blum). Mackinac Co.: Mackinac I. (Hermann).

Fissidens adianthoides Hedw. On soil or humus, rocks, logs, stumps, bark at base of trees, and exposed roots in woods. Cheboygan Co.: Reese's Bog (Mazzer); Fontinalis Run (Roberts); Carp Creek (Gleason); Iron Bridge, Carp

Creek (Crum); Gorge of Carp Creek (Crum); near Levering (Kubsch); Duncan Bay (Sharp; Steere). Emmet Co.: Maple R. (Kubsch); Cecil Bay (Wynne; Crum). Mackinac Co.: Pointe-aux-Pins, Bois Blanc I. (Steere).

Fissidens cristatus Wils. ex Mitt. On soil or humus, bark at base of trees or on exposed roots, rotten wood, and rocks in woods. Cheboygan Co.: Gorge of Carp Creek (Fulford; Gleason); Mud L. (Wynne); Wolff's Bog (Fulford). Emmet Co.: Pellston (Nichols); Maple R. (Fulford); Wycamp Creek (Gleason). Mackinac Co.: Mackinac I. (Kubsch).

Fissidens osmundioides Hedw. On soil, humus, rocks, or logs. Cheboygan Co.: Reese's Bog (Pagán); Iron Bridge, Carp Creek (Gleason). Emmet Co.: Cecil Bay (Wynne); Big Stone Creek (Steere). Mackinac Co.: Bois Blanc I. (Wynne). Presque Isle Co.: Hammond Bay (Hatcher).

Fissidens taxifolius Hedw. On soil and rock. Emmet Co.: Cecil Bay (Frodin). The specimen, though poor, almost certainly belongs here.

Fissidens obtusifolius Wils. var. *apiculatus* Grout. On wet limestone (and perhaps non-calcareous rocks as well) in or along streams. Mackinac Co.: Bois Blanc I. (Lawton).

Fissidens bryoides Hedw. On moist soil and rock, often in or along brooks, rarely on exposed roots. Cheboygan Co.: Mill Creek (Wynne — the "*F. exiguus*" form). Emmet Co.: Wilderness State Park (Wagoner — the "*F. viridulus*" form). Mackinac Co. : Mackinac I. (Nichols — the "*F. minutulus*" form, verging toward "*F. viridulus*").

DITRICHACEAE

Distichium capillaceum (Hedw.) BSG. Typical of damp, shaded, calcareous rocks and cliffs, but also found on soil or humus. Cheboygan Co.: Iron Bridge, Carp Creek (Arzeni). Emmet Co.: Cecil Bay (Robinson & Crum; Frodin); Big Stone Creek (Steere). Mackinac Co.: Mackinac I. (Nichols).

Distichium inclinatum (Hedw.) BSG. On damp rocks or cliffs, also on soil or humus of sheltered banks. Cheboygan Co.: Gorge of Carp Creek (Nichols). Emmet Co.: Big Stone Creek (Steere).

Saelania glaucescens (Hedw.) Broth. On soil (often calcareous), typically on steep banks, particularly in the protection of overhanging turf, frequently at roadsides, and also on rocks or soil in rock crevices. Cheboygan Co.: Lake Bluff near Bryant's Bog (Nichols); vicinity of Burt and Douglas Lakes (Nichols).

Ceratodon purpureus (Hedw.) Brid. A weed, exceedingly common on soil and sometimes rock or old wood, usually in dry, open, disturbed places, often growing on old roofs. Cheboygan Co.: Grapevine Pt., Douglas L. (Steere); Pine Pt., Douglas L. (Crum); S. Fishtail Bay, Douglas L. (Arzeni); Reese's Bay (Wynne); Smith's Bog (Nichols & Ehlers); Gorge of Carp Creek (Crum); Bryant's Bog (Roberts); Colonial Pt., Burt L. (Nichols); Ellis Twp. (Hatcher); Inverness Twp. (Hatcher). Emmet Co.: Cecil Bay (Wynne); Carp L. (Ehlers); Maple R. Twp. (Hatcher); Stutsmanville (Robinson & Sharp). Mackinac Co.: Bois Blanc I. (Wynne); Pointe-aux-Pins, Bois Blanc I. (Steere); Prentiss Bay (Ehlers). Presque Isle Co.: Hammond Bay (Hatcher); Presque Isle lighthouse (Wetmore); Ocqueoc Falls (Steere).

Ditrichum flexicaule (Schwaegr.) Hampe. A calciphile extremely common in the North and in the Rocky Mts., typically on cliffs, but also common on soil, locally found on calcareous sand along the shore of Lake Michigan and Lake Huron. Cheboygan Co.: Duncan Bay (Sharp). Emmet Co.: Cecil Bay (Sharp; Brask). Mackinac Co.: Mackinac I. (Nichols; Wells; Sharp).

SELIGERIACEAE

Seligeria campylopoda Kindb. ex Macoun & Kindb. On limestone, particularly on cliffs, generally in moist, shaded places. Cheboygan Co.: Grapevine Pt., Douglas L. (Kubsch); Colonial Pt., Burt L. (Nichols); Mill Creek (Crum). Emmet Co.: Near Mackinaw City (Sharp); Wilderness State Park (Robinson & Crum); Big Stone Bay (Steere). Mackinac Co.: Mackinac I. (Nichols; Grant; Woollett; Steere); Deer L., Bois Blanc I. (Robinson & Crum; Embree).

Seligeria doniana (Sm.) C.M. On calcareous rock, in moist, shaded places, generally on cliffs. Mackinac Co.: Near Arch Rock, Mackinac I. (Steere).

DICRANACEAE

Trematodon ambiguus (Hedw.) Hornsch. On moist, disturbed soil along roads and on banks of ditches or streams in more or less open situations. Cheboygan Co.: Colonial Pt., Burt L. (Fulford).

Dicranella heteromalla (Hedw.) Schimp. On soil or humus, often in disturbed places, especially on roadside banks and along trails through rather dry, open woods. Cheboygan Co.: Grapevine Pt., Douglas L. (Crum); Douglas L. (Nichols); Colonial Pt., Burt L. (Robinson & Crum; Smith); Lancaster L. (Ehlers); Munro L. (Ehlers); Mud L. (Roberts). Emmet Co.: Pellston (Nichols)..

Dicranella varia (Hedw.) Schimp. On disturbed soil, especially on moist banks of ditches and at roadsides in open situations.Cheboygan Co.: Colonial Pt., Burt L. (Robinson & Crum). Mackinac Co.: Mackinac I. (Nichols).

Dicranella schreberiana (Hedw.) Schimp. On wet soil (often clay), on banks of roads, ditches, and streams. Mackinac Co.: Mackinac I. (Nichols). This specimen has entire leaves and ± striate capsules and thus fulfills the requirements for *D. grevilleana,* which I consider an unimportant and intergrading expression of *D. schreberiana.* —Var. *elata* Schimp. On wet soil in roadside ditches and creek beds. Cheboygan Co.: Douglas L. (Nichols); Gorge of Carp Creek (Wynne). Mackinac Co.: Bois Blanc I. (Wynne); Pointe-aux-Pins — Sandy Bay Rd., Bois Blanc I. (Steere). Presque Isle Co.: Hammond Bay (Steere).

Oncophorus wahlenbergii Brid. Typically on moss-covered, decayed logs in moist forests, rarely on soil, rock, or trunks of trees. Cheboygan Co.: Gorge of Carp Creek (Pagán); Iron Bridge, Carp Creek (Fulford); Reese's Bog (Roberts; Fulford; Feigley; Wynne). Emmet Co.: Upper Maple R. (Robinson); Cecil Bay (Wynne; Berkeley). Mackinac Co.: Bois Blanc I. (Wynne).

Dicranum montanum Hedw. Very common on rotten logs and stumps and the bark of trees, particularly on their bases or exposed roots; also frequent on rock, rare on soil or humus. Cheboygan Co.: Reese's Bog (Crum; Crum & Robinson; Nichols); Wolff's Bog (Fulford); Mud L. (Wynne); Colonial Pt., Burt L. (Nichols). Emmet Co.: Maple R. Twp. (Hatcher); Cecil Bay (Wynne). Mackinac Co.: Bois Blanc I. (Wynne). Presque Isle Co.: Hammond Bay (Hatcher).

Dicranum flagellare Hedw. Very common on rotten logs and stumps, occasional on humus, bark at base of trees, soil, and rock. Cheboygan Co.: Reese's Bog (Wynne; Pagán; Roberts); Wolff's Bog (Fulford); Gorge of Carp Creek (Fulford); Mud L. (Hatcher). Emmet Co.: Wycamp L. (Koch). Mackinac Co.: Bois Blanc I. (Wynne; Kubsch).

Dicranum viride (Sull. & Lesq. ex Sull.) Lindb. Frequent on the bark of trees, especially on their bases and exposed roots, occasional on rock or earth. Cheboygan Co.: Reese's Bog (Roberts); Carp Creek (Pagán); Gorge, Carp

Creek (Mazzer); Colonial Pt., Burt L. (Kubsch; Nichols); Mud L. (Wynne). Emmet Co.: Pellston Hardwoods (Nichols); Cross Village (Kubsch). Mackinac Co.: Mackinac I. (Kubsch); Pointe-aux-Pins, Bois Blanc I. (Steere).

Dicranum undulatum Brid. [*D. bergeri* Bland.] Characteristic of open peat bogs and heaths, often growing in *Sphagnum* hummocks (frequently under clumps of black spruce), less common in *Thuja* swamps and wet spruce stands. Cheboygan Co.: Maloney's Bog (Kubsch); Mud L. (Wynne; Steere). Emmet Co.: Stutsmanville (Robinson); Cecil Bay (Wynne). Presque Isle Co.: Hammond Bay (Wynne).

Dicranum sabuletorum Ren. & Card. [*D. condensatum* Hedw. in part]. On sand or other light soil, rarely on humus, in open, dry, coniferous woods, often on thin soil overlying rocks. Emmet Co.: Wycamp L. (Steere; Koch); Big Stone Bay (Nichols).

Dicranum drummondii C.M. On humus, rarely on rotten wood, in rather dry or moist coniferous forests, apparently sometimes in open *Sphagnum* bogs. Cheboygan Co.: Iron Bridge, Carp Creek (Fulford); Reese's Bog (Nichols); Bryant's Bog (Kubsch). Emmet Co.: Wilderness State Park (Crum); Big Stone Bay (Nichols); Cecil Bay (Bevis); Stutsmanville (Robinson & Sharp).

Dicranum spurium Hedw. On light, often sandy soil or rock, apparently limited to exposed places, such as dry ledges, dry scrub oak, aspen, or pine woods, and rocky heaths or barrens. Cheboygan Co.: Devereaux L. (Fulford). Emmet Co.: Cecil Bay (Wynne); Wycamp L. (Steere).

Dicranum fuscescens Turn. A forest species, growing on rotten logs and stumps or bark of exposed roots or bases of trees, sometimes on soil or humus. Cheboygan Co.: Iron Bridge, Carp Creek (Fulford); Reese's Bog (Nichols). Emmet Co.: Big Stone Bay (Nichols). Mackinac Co.: Prentiss Bay (Ehlers).

Dicranum scoparium Hedw. Very common and wide-ranging, typically on soil in fairly dry or rather moist forests, also common on humus, rocks, bark of exposed roots and bases of trees, and rotten wood. Cheboygan Co.: Douglas L. (Hermann; Ehlers); Reese's Bog (Roberts; Nichols; Steere); Gorge of Carp Creek (Wynne; Ehlers; Nichols & Ehlers); Colonial Pt., Burt L. (Loveland; Ehlers). Emmet Co.: Wilderness State Park (Frodin); Cecil Bay (Sharp; Wynne); Carp L. (Ehlers). Mackinac Co.: Mackinac I. (Kauffman); Bois Blanc I. (Wynne); Prentiss Bay (Ehlers). Presque Isle Co.: Presque Isle lighthouse (Wetmore).

Dicranum polysetum Sw. [*D. rugosum* Brid.] Typically on humus, sometimes on soil (often on thin soil or humus over rocks), in shaded, rather dry or moist situations. Cheboygan Co.: Reese's Bog (Robinson & Mickel; Wynne; Roberts; Kubsch); Carp Creek (Pagan); Pine Pt., Douglas L. (Fulford); Burt L. (Steere); Little Lake Sixteen (Cobbe). Emmet Co.: Waugoshance Pt. (Smith); Cecil Bay (Wynne); Big Stone Bay (Nichols); Stutsmanville (Robinson & Sharp). Mackinac Co.: Bois Blanc I. (Wynne; Steere); Prentiss Bay (Ehlers). Presque Isle Co.: Hammond Bay (Hatcher); Presque Isle lighthouse (Wetmore).

Paraleucobryum longifolium (Hedw.) Loeske. Most commonly on rocks in moist woods, but also on tree trunks (especially at the bases), rotten logs, and rarely humus or soil. Cheboygan Co.: Colonial Pt., Burt L. (Lersten & Sharp). Emmet Co.: Cecil Bay (Mazzer). Mackinac Co.: Mackinac I. (Steere).

LEUCOBRYACEAE

Leucobryum glaucum (Hedw.) Schimp. Common in moist forests on soil and less commonly humus, occasionally on rotten logs or stumps, in rock crevices, or on bark at base of trees. Cheboygan Co.: Gorge of Carp Creek

(Roberts); Iron Bridge, Carp Creek (Fulford). Emmet Co.: Cecil Bay (Wynne). Mackinac Co.: Bois Blanc I. (Wynne).

ENCALYPTACEAE

Encalypta ciliata Hedw. On rocks (often calcareous), on ledges or in crevices of cliffs, also on soil of banks, especially in the shelter of overhanging sod. Cheboygan Co.: Fairy I., Douglas L. (Roberts; Nichols); Cheboygan (Clark). Emmet Co.: Cross Village (Fulford; Mazzer).

Encalypta rhaptocarpa Schwaegr. On soil, often in crevices of dry, calcareous cliffs or in the shelter of turf overhanging banks. Cheboygan Co.: Fairy I., Douglas L. (Nichols). Emmet Co.: Cross Village (Robinson & Crum). Mackinac Co.: Mackinac I. (Woollett).

Encalypta procera Bruch. Typically (if not always) a calciphile, growing on or in crevices of damp rocks and cliffs and also on soil of cliff ledges and roadbanks. Emmet Co.: Good Hart (Schnooberger); Cross Village (Frodin; Mazzer); Big Stone Bay (Nichols); Cecil Bay (Nichols & Ehlers). Mackinac Co.: Mackinac I. (Kubsch; Nichols); Castle Rock (Koch). Presque Isle Co.: Ocqueoc Falls (Steere).

POTTIACEAE

Gymnostomum aeruginosum Sm. On moist or wet, shaded, calcareous cliffs or boulders, rarely on soil. Cheboygan Co.: Mill Creek (Robinson & Crum; Wynne). Mackinac Co.: Mackinac I. (Nichols); Castle Rock (Koch).

Gymnostomum recurvirostrum Hedw. Common and widespread on wet, calcareous cliffs, locally found on low ridges of dune sand around moist depressions along the south shore of the Straits. Emmet Co.: Cecil Bay (Nichols).

Weissia controversa Hedw. [*W. viridula* Hedw.] On bare soil, usually in exposed and generally disturbed habitats, in old fields, along roads or paths, in cracks of sidewalks, and frequently on soil in crevices of old, dry logs. Cheboygan Co.: Biological Station campus (Forman).

Tortella inclinata (Hedw. f.) Limpr. [*T. inclinatula* (C.M. & Kindb.) Broth.] Rare, apparently on calcareous soil or rock, found on dune sand in a few Great Lakes localities. Emmet Co.: Cross Village (Sharp; Kubsch); Sturgeon Bay (Frodin; Mazzer); Cecil Bay (Frodin).

Tortella humilis (Hedw.) Jenn. On soil and rocks (usually calcareous), bark of exposed roots or the bases of trees and stumps, also on old logs. Cheboygan Co.: Fairy I., Douglas L. (Nichols).

Tortella tortuosa (Hedw.) Limpr. On damp calcareous soil or rock, sometimes on humus. Cheboygan Co.: Fairy I., Douglas L. (Roberts). Emmet Co.: Sturgeon Bay (Kubsch); Cecil Bay (Wynne; Zwickey; Feigley; Nichols & Ehlers); Big Stone Creek (Robinson & Crum); Big Stone Bay (Ehlers); Wilderness State Park (Pagán; Crum). Mackinac Co.: Bois Blanc I. (Wynne; Kubsch); Prentiss Bay (Ehlers). Presque Isle Co.: Ocqueoc Falls (Crum); Presque Isle lighthouse (Wetmore).

Tortella fragilis (Hook. & Wils. ex Drumm) Limpr. On damp, calcareous rock and frequently on sandy soil or humus near lakes and streams. Cheboygan Co.: Carp Creek (Crum); Iron Bridge, Carp Creek (Fulford; Crum). Emmet Co.: Cecil Bay (Roberts; Wynne); Wilderness State Park (Feigley). Presque Isle Co.: Hammond Bay (Hatcher).

Barbula convoluta Hedw. On exposed, calcareous soil, often in disturbed places (common on roadbanks, along paths, and in old fields). Cheboygan Co.: Grapevine Pt., Douglas L. (Steere); Campbell Quarry, Afton (Steere); Fairy I., Douglas L. (Nichols). Emmet Co.: Cecil Bay (Chopra). Mackinac Co.: Bois Blanc I. (Wynne); Garnet (Steere).

Barbula unguiculata Hedw. On disturbed, calcareous soil in exposed places, in old paths, along roads, on roadbanks, and in old fields. Cheboygan Co.: Biological Station campus (Kubsch); Mill Creek (Crum); near Mackinaw City (Nichols); Campbell Quarry, Afton (Steere). Emmet Co.: Upper Maple R. (Robinson). Mackinac Co.: Pointe-aux-Pins, Bois Blanc I. (Steere). Presque Isle Co.: 23 mi. N. of Rogers City (Hermann). Nichols' report of *Desmatodon obtusifolius* (Schwaeger.) Schimp. from a ''moist limestone ledge near Mackinaw City'' belongs here.

Barbula fallax Hedw. On damp, calcareous soil, often on rocky roadbanks. Cheboygan Co.: Biological Station campus (Steere); Campbell Quarry, Afton (Steere). Emmet Co.: Conway (Schnooberger). Mackinac Co.: Mackinac I. (Sivon; Nichols); Pointe-aux-Pins, Bois Blanc I. (Steere). Presque Isle Co.: Ocqueoc Falls (Steere).

Didymodon rigidulus Hedw. On damp or wet calcareous rocks and soil. Mackinac Co.: Mackinac I. (Nichols).

Bryoerythrophyllum recurvirostrum (Hedw.) Chen [*Didymodon recurvirostris* (Hedw.) Jenn.]. A common calciphile, usually on moist soil or rocks, often in disturbed, open situations (such as roadbanks), but also flourishing in deep, undisturbed woods on wet logs, rotten stumps, etc. Cheboygan Co.: Bryant's Bog (Nichols); Carp Creek (Pagán); Gorge of Carp Creek (Wynne; Crum; Arzeni); Iron Bridge, Carp Creek (Fulford; Steere); Carp Creek (Nichols); near Levering (Kubsch). Emmet Co.: Cecil Bay (Wynne; Crum); Big Stone Creek (Steere); Wilderness State Park (Steere). Mackinac Co.: Pointe-aux-Pins, Bois Blanc I. (Steere). Presque Isle Co.: Hammond Bay (Steere).

Tortula mucronifolia Schwaegr. On calcareous soil in crevices of cliffs and boulders and frequently in sheltered niches on banks or on and among rocks. Cheboygan Co.: Colonial Pt., Burt L. (Nichols); Fairy I., Douglas L. (Nichols); Mill Creek (Robinson & Crum). Emmet Co.: Cross Village (Robinson & Crum); Cecil Bay (Robinson & Sharp).

Tortula ruralis (Hedw.) Crome. On soil or rock in dry, sunny, usually calcareous habitats, frequent in disturbed places (roadsides, pastures, etc.), common locally on dune sand. Cheboygan Co.: Mill Creek (Crum; Wynne); Colonial Pt., Burt L. (Robinson & Crum). Emmet Co.: Cecil Bay (Roberts; Zwickey; Wynne; Nichols; Steere); Wilderness State Park (Kubsch; Pagán); Cross Village (Kubsch); Big Stone Bay (Nichols). Mackinac Co.: Mackinac I. (Hermann; Patterson); Bois Blanc I. (Kubsch; Wynne; Steere). Presque Isle Co.: Hammond Bay (Steere).

GRIMMIACEAE

Grimmia alpicola Hedw. On wet or dry rocks (often calcareous). Cheboygan Co.: Mill Creek (Crum); Colonial Pt., Burt L. (Nichols). Emmet Co.: Cross Village (Fulford); Wilderness State Park (Pagán): Cecil Bay (Wynne; Zwickey); Mackinac Co.: Mackinac I. (Hermann); Bois Blanc I. (Steere). Presque Isle Co.: Grand L. (Hermann).—Var. *rivularis* (Brid.) Wahl. On wet rocks in or beside streams (frequently calciphilous). Cheboygan Co.: Mill Creek (Wynne; Steere).

Rhacomitrium heterostichum (Hedw.) Brid. On non-calcareous rocks, rarely on soil, often in dry, exposed places; the only local collection came from an erratic boulder at Cecil Bay, Emmet Co., N.W. Katz, July 25, 1941.

FUNARIACEAE

Physcomitrium pyriforme (Hedw.) DeNot. [*P. turbinatum* (Mx.) Brid.] Very common in the spring on sterile, disturbed soil, frequently found in paths, along roads, and on bare soil in old fields. Cheboygan Co.: Colonial Pt., Burt L. (Fulford); Inverness Twp. (Hatcher).

Funaria hygrometrica Hedw. A weed, very common on soil in disturbed habitats, often in burned-over places, sometimes on old wood or rock in wet or dry habitats (common in lawns and greenhouses). Cheboygan Co.: Inverness Twp. (Hatcher); Gorge of Carp Creek (Pagán); Reese's Bog (Wynne; Feigley); Bryant's Bog (Roberts). Emmet Co.: Upper Maple R. (Robinson); Cross Village (Arzeni); Good Hart (Kubsch); Cecil Bay (Roberts). Mackinac Co.: Wishing Springs, Mackinac I. (Clark & Emmitt); Bois Blanc I. (Wynne); Point-aux-Pins, Bois Blanc I. (Steere).

BRYACEAE

Leptobryum pyriforme (Hedw.) Schimp. On damp or wet, sandy or peaty soil and decaying wood, frequently in disturbed places (greenhouses, burnt patches of soil, roads through swamps, etc.). Cheboygan Co.: Reese's Bog (Roberts; Crum); Gorge of Carp Creek (Wynne; Crum; Kubsch); Iron Bridge, Carp Creek (Steere); Biological Station (Pagán).

Pohlia cruda (Hedw.) Lindb. On soil or humus in moist, shaded places, particularly in crevices of cliffs and on banks, often in the protection of overhanging turf (common in calcareous habitats). Cheboygan Co.: Douglas L. (Hermann); Grapevine Pt., Douglas L. (Roberts). Emmet Co.: Cross Village (Robinson & Crum); dam, Maple R. (Robinson & Crum).

Pohlia nutans (Hedw.) Lindb. Common, on various wet or dry substrata, such as decaying logs, tops of old, rotten stumps, humus in heaths or bogs, old *Sphagnum* hummocks, and soil in rock crevices. Cheboygan Co.: Reese's Bog (Frodin); Gorge of Carp Creek (Pagán); Iron Bridge, Carp Creek (Fulford; Sharp); Mud L. (Hatcher; Wynne). Emmet Co.: Stutsmanville (Robinson & Sharp). Mackinac Co.: Bois Blanc I. (Wynne).

Pohlia wahlenbergii (Web. & Mohr) Andr. On wet soil near springs, on wet banks, in ditches, and in other seepy habitats, generally in the open. Cheboygan Co.: Burt L. (Nichols). Emmet Co.: Big Stone Creek (Steere); Big Stone Bay (Nichols & Ehlers); Wilderness State Park (Wagoner); Maple R. (Crum). Mackinac Co.: Bois Blanc I. (Wynne): Pointe-aux-Pins, Bois Blanc I. (Steere).

Pohlia pulchella (Hedw.) Lindb. On damp, clayey soil, on roadbanks and sides of ditches. Mackinac Co.: Mackinac I. (Nichols).

Bryum argenteum Hedw. A common, widely distributed weed in exposed, usually dry places, often on soil of paths, cracks of sidewalks, or old fields, sometimes on bricks, roofs, dry logs, etc. Cheboygan Co.: Douglas L. (Roberts); Biological Station campus (Crum; Kubsch); Colonial Pt., Burt L. (Nichols). Emmet Co.: Cecil Bay (Frodin).

Bryum capillare Hedw. On moist soil or humus, decayed wood, rocks and common also on soft bark at bases of trees or in weathered crotches and drainage channels of trees. Emmet Co.: Big Stone Bay (Nichols & Ehlers; Ehlers); Cecil Bay (Nichols); Cross Village (Sharp).

Bryum caespiticium Hedw. On poor, sandy or loamy soil in disturbed places. Cheboygan Co.: Reese's Bog (Wynne); Colonial Pt., Burt L. (Crum). Emmet Co.: Big Stone Bay (Nichols).

Bryum creberrimum Tayl. [*B. cuspidatum* (BSG) Schimp.] On rocky or sandy soil (typically rather wet), often on roadbanks, sides of ditches, crevices of cliffs, sometimes on rock, humus, or rotten wood. Cheboygan Co. (Reese's Bog (Gleason); Gorge of Carp Creek (Roberts); Ellis Twp. (Hatcher); Long L. (Fulford); Pine Pt., Douglas L. (Fulford); Fairy I., Douglas L. (Nichols); Douglas L. (Roberts). Emmet Co.: Wycamp L. (Gleason). Presque Isle Co.: Presque Isle lighthouse (Wetmore).

Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer, & Scherb. On wet soil or humus, sometimes on rocks or decayed wood, common in swamps or near brooks and ponds. Cheboygan Co.: Trout Creek (Gleason). Reese's Bog (Nichols; Sharp); Gorge of Carp Creek (Crum; Kubsch; Nichols; Nichols & Ehlers); Mill Creek (Wynne); Inverness Twp. (Hatcher); Sturgeon R. (Bryant). Emmet Co.: Wycamp L. (Gleason); Cecil Bay (Crum; Wynne; Nichols); Big Stone Bay (Nichols); Carp L. (Ehlers). Mackinac Co.: Bois Blanc I. (Wynne); Mackinac I. (Gleason). Presque Isle Co.: Hammond Bay (Steere); Grace Harbor (Gleason).

Bryum uliginosum (Brid.) BSG. On peaty or sandy banks of streams or on rocks or rotten wood in wet places, probably a calciphile. Cheboygan Co.: Carp Creek (Crum); Iron Bridge, Carp Creek (Sharp; Steere; Pagán).

Bryum angustirete Kindb. ex Macoun [*B. pendulum* (Hornsch.) Schimp.]. On sand or gravel, occasionally on humus, often in wet places, sometimes on rock ledges or in crevices of cliffs and on gravel seeps; locally on sand in depressions in low dunes near the shore of the Straits. Emmet Co.: Cecil Bay (Crum); Big Stone Bay (Nichols). Presque Isle Co.: Grace Harbor (Gleason).

Rhodobryum roseum (Hedw.) Limpr. Usually on thin humus or soil over boulders in woods, sometimes on the forest floor, on logs, or on bark at the base of trees. Cheboygan Co.: Grapevine Pt., Douglas L. (Kubsch); Fontinalis Run (Roberts); Mud L. (Wynne); Inverness Twp. (Hatcher); Ellis Twp. (Hatcher). Emmet Co.: Cecil Bay (Wynne); Harbor Springs (Kubsch). Mackinac Co.; Bois Blanc I. (Wynne). Presque Isle Co.: Presque Isle lighthouse (Wetmore).

MNIACEAE

Mnium cuspidatum Hedw. On soil, humus, and rotten logs in moist woods (frequently on banks or low mounds) and often in fairly open, disturbed places. Cheboygan Co.: Mud L. (Wynne; Nichols); Reese's Bog (Kubsch); Colonial Pt., Burt L. (Crum). Emmet Co.: Pellston Hardwoods (Nichols). Mackinac Co.: Bois Blanc I. (Benninghoff). Presque Isle Co.: Hammond Bay (Steere).

Mnium drummondii, Bruch & Schimp. On shaded, moist soil, humus, and rocks. Cheboygan Co.: Reese's Bog (Nichols; Steere). Mackinac Co.: Mackinac I. (Kauffman).

Mnium medium BSG. On swampy soil in woods. Cheboygan Co.: Ellis Twp. (Hatcher); Colonial Pt., Burt L. (Nichols). Mackinac Co.: Mackinac I. (Kauffman).

Mnium affine Bland. ex Schwaegr.—var. *rugicum* (Laur.) BSG. On soil, humus, or rock, in wet places along streams, near springs or pools, often under willows in open swamps, or in boggy woods. Cheboygan Co.: E. of Burt L. (Nichols); Mud L. (Sharp).—Var. *ciliare* (Grev.) C.M. On soil or humus, less frequently on rock, rotten wood, or bark at base of trees, in moist woods. Cheboygan Co.: Iron Bridge, Carp Creek (Frodin); Gorge of Carp Creek (Crum; Pagán); Carp Creek (Crum); Reese's Bog (Crum; Gleason; Pagan; Nichols; Colonial Pt., Burt L. (Nichols); Mud L. (Mazzer). Emmet Co.: Pellston Hardwoods (Nichols). Presque Isle Co.: Presque Isle lighthouse (Wetmore).

(To be continued)

RHIZOPOGON
A Curious Genus of False Truffles

Alexander H. Smith
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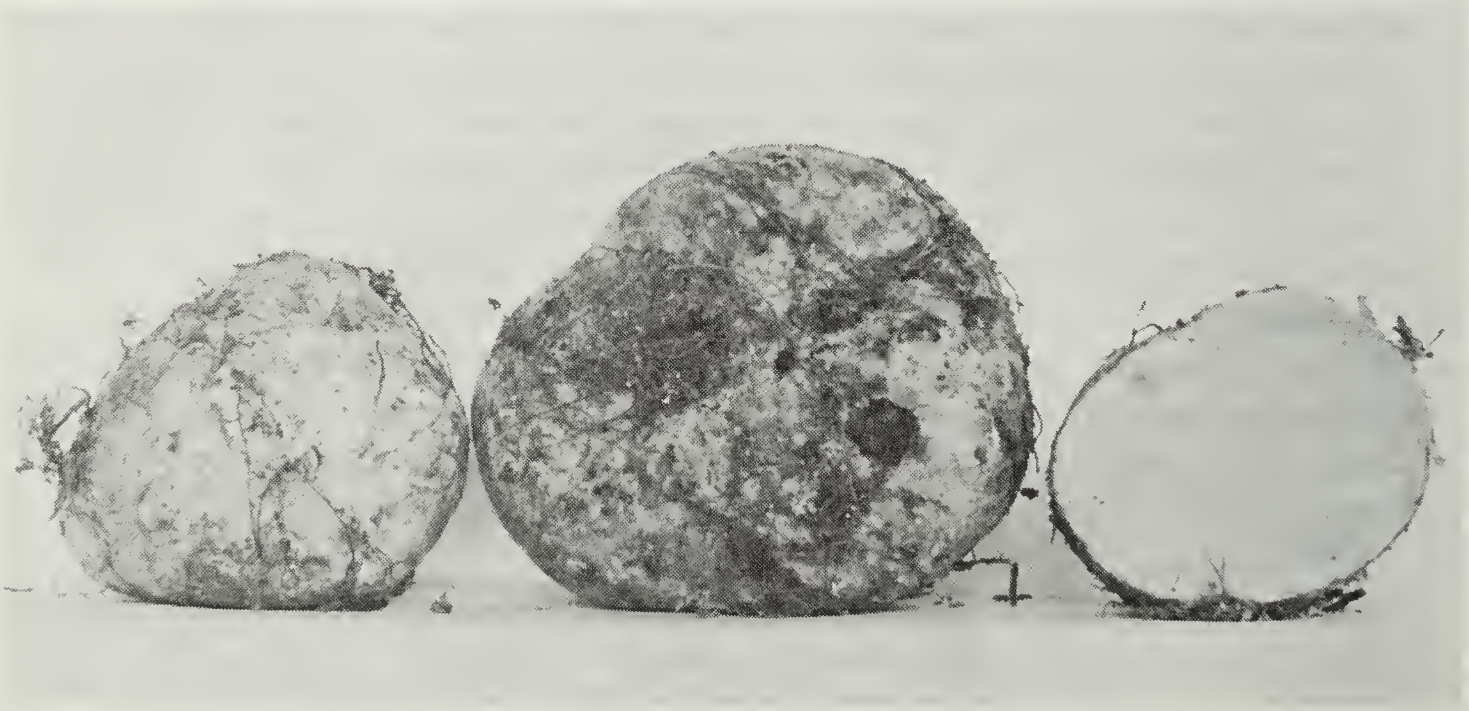
For a number of years I have been very concerned with fungi which produce fruiting bodies in the ground or in the duff of the forest floor. Some rather startling information on a group of these, the genus *Rhizopogon,* has come to light. I have now worked out what I consider to be reasonably accurate species concepts for the North American species. The problem remains to establish the distribution patterns of these species. To do this I need the help of interested collectors everywhere. I have had good luck finding species of *Rhizopogon* in the Pacific Northwest, but do not have as many species from Michigan as should occur here. With the silica gel technique for drying them as described by Mrs. Hoseney in this journal (2: 125-126. 1963), this phase of preparing specimens is now quick, simple, and safe, and involves very little mess. I should like all collections of *Rhizopogon* or *Rhizopogon*-like fungi that can be found here in the Great Lakes region. In order to be sure that the specimens can be identified, record the colors as you observe them at the time of collection, test for color changes on bruised parts, and test with the chemicals as explained below. Include all these data on a slip of paper on which is also the name of the collector, the place of collection, and if possible the kinds of trees within 50 feet of the spot. Then cut each gastrocarp in half, bury them in silica gel until dry, and send them to me along with the notes.

The next question is: Where are you going to find these fungi? Frankly, this is one of the two major problems I am trying to explore. The other, as already mentioned, is: How widely are they distributed in the region? From most indications so far it appears that these fungi are found mostly in the duff under conifer trees, but I am very anxious for any that are found under hardwood trees in woods where no conifers are present. Most of these fungi apparently form mycorrhiza with forest trees. They seem to prefer well drained soil; at least I seldom find them in boggy ground, but they are often common close to the edge of a bog. The best time to look for them is during the late summer and fall, but since we know so little of their occurrence in our region we cannot say that none of them have earlier fruiting periods.

My technique for finding them is based on a few simple principles. In the first place the gastrocarps form and grow in the duff of the forest floor; in fact they are often found in the zone separating the mineral soil from the duff. As they mature they push up the duff somewhat, or break it enough so that part of the gastrocarp can be seen. The first thing to do, then, is to look for bumps in the duff, or cracks, and dig around in these areas with a small garden implement such as a 3-pronged hand cultivator small enough to be carried easily. Most of the bumps, of course, will have rocks under them. Do not let this discourage you. It is not at all uncommon to find that rodents such as squirrels have been digging in an area. In such places I always dig too, on the off chance that the animals missed some. Of course, the squirrels may be digging bulbs instead of fungi, but this is a chance you have to take. Often one can find a partly eaten gastrocarp on a stump where a rodent left it for one reason or another. When this happens, look the surrounding area over very carefully. In the Rocky Mountains *Rhizopogon* species often fruit as the duff dries out, and this possibility should be checked in our region. For instance, if heavy rainfall occurs in early September, The *Rhizopogon* crop should be good later in the month as the duff dries out. In other words, the time to hunt for these fungi is after the main fruiting of mushrooms and other fleshy fungi is fairly well along.

In the pine plantations of southeastern Michigan a few species have been found in abundance; some of my students have eaten them after deep-frying them. So far no illness has been reported, and the flavor is apparently rather good. However, we do not know what species are actually involved. The two which I reported in *Puffballs and Their Allies in Michigan* (Univ. Mich. Press, p. 18-20, 1951) are European species, and now I am not sure that they are correctly identified.

As is shown, fig. 1, the fruiting body, often referred to as a



false truffle (true truffles are Ascomycetes, not Basidiomycetes), is not very exciting to look at. The basic shape is roughly that of a sphere, but variations to flattened or rather irregular in outline are common. Since these structures, also called gastrocarps, often grow in clusters, it is common to find them irregular in shape from mutual pressure, or from pressure of roots, stones, etc., with which they come in contact as they develop. One of the distinctive field characters of *Rhizopogon* is that there is no distinct basal attachment; instead there are usually scattered coarse strands of mycelium called rhizomorphs variously distributed over the surface. There is not much range in color for the various species. The commonest pattern is for the gastrocarp to be white when young, gradually become some shade of yellow; and in age, where exposed to light, or after bruising, becoming yellow-brown to reddish brown. A number of species are white at first and slowly become dull brown and in age or when dried are almost black. Certain other color changes are also to be noted. In both of the groups mentioned above, the surface in many species stains red to some degree when it is injured. This is a much more common character in the genus than has been supposed previously, but it is still a very important character and must be observed at the time the material is collected.

In the course of detailed studies of species of *Rhizopogon* in central Idaho it was found that certain chemical tests gave very distinctive reactions. Iron salts such as $FeSO_4$ gave distinctive color reactions varying from olive to olive-black. This reaction is obtained by simply placing a few drops of the solution on the surface of fresh gastrocarps. If a color change is going to develop, it will occur in a few minutes. A second set of reactions is obtained by applying a weak solution of potassium hydroxide (KOH), usually 2 to 5% in aqueous solution. Four different color reactions are known: 1) The surface may become dark rusty brown where the chemical is applied; 2) The change is to pale to dark red, purplish, or lilac; 3) A change to green to inky black occurs; 4) Some species do not show a color change. Certain precautions must be observed when making these tests: Do not allow KOH and $FeSO_4$ to come into contact with each other — this always gives a green reaction. Cut the gastrocarp in half and test one half with one chemical and the other half with the other. With notes on the color pattern of the gastrocarp from youth to old age, color changes on bruising, the color reactions obtained with the above chemicals, any odd characters such as the presence of a peculiar odor, and the color of the interior in young and old specimens, the specimens can be readily identified if dried by the silica gel technique.

The following classification to sections is one I have worked out largely from herbarium specimens and my own material from the Pacific Northwest. The treatment for North America will contain upwards of 75 species and is too large to be included here.

RHIZOPOGON Fries & Nordholm

Symb. Gast. 1: 5. 1817.

Gastrocarps globose, compressed, or variously irregular in shape, lacking a distinct basal attachment; gleba of chambers of various sizes and shapes, usually empty; columella absent; tramal plates made up of more or less gelatinous hyphae; spores smooth or only very obscurely ornamented, typically 6 or 8 on a basidium and usually nearly sessile, hyaline to yellow-brown; paraphyses typically septate.

Type species: *Rhizopogon luteolus* Fries & Nordholm

Key to Sections of *Rhizopogon*

1. Clamp connections present on hyphae of the peridial epicutis (the wall of the gastrocarp) ---------------------------- Section *Fibulatae*
1. Clamp connections not present on hyphae of the gastrocarp wall ---------- 2
2. Spores distinctly amyloid at maturity (blue in iodine) - Section *Amylopogon*
2. Spores not amyloid at maturity ------------------------------------- 3
3. Gastrocarp with an epicutis of hyphae loosely interwoven (or representing a tangled trichodermium); thin to thick-walled dark brown mostly smooth-walled elements and flagellate-like terminal cells often present ---------------------------- Section *Villosuli*
3. Peridial epicutis not as described above ---------------------------- 4
4. Spores 12-20 μ long, 5-8 μ wide and variable in shape, dull brown in KOH ----------------------------------- Section *Megasporae*
4. Spores smaller than in above and more regular in shape, hyaline to yellow or yellow brown in KOH ------------------------ 5
5. Gleba yellow-brown to dark rusty brown, wood-brown or umber-brown at maturity, or, if not any of these colors, then staining yellow when cut ----------------------------------- Section *Fulviglebae*
5. Gleba white to olive buff, olive or olive brown but often drying pinkish buff, not changing color when cut ------------- Section *Rhizopogon*

Section Fibulatae sec. nov.

Hyphae peridiorum fibulatae.

Typus: *Rhizopogon diplophloeus* Zeller & Dodge.

RHIZOPOGON DIPLOPHLOEUS Zeller & Dodge, Ann. Mo. Bot. Gard. 5:8. 1918.

Gastrocarp 1-2.5 cm in diam., globose to rather irregular in outline; color when fresh "clay color" but becoming darker brown on bruising and when dried blackish with some ochraceous tones showing in the depressions; surface scantily fibrillose from appressed fibrils, few rhizomorphs present, with scattered appressed fibrils leading to the scattered rhizomorphs. Gleba with irregular cavities, at maturity filled with spores, color when dry near russet and consistency bone hard. Columella absent.

$FeSO_4$ on sections of dried material—dark green on both the gleba and the peridium. KOH giving a reddish pigment diffusing from the peridium into the mounting medium but the peridium itself soon rusty brown in sections.

Spores 4.5-5.5 x 2.3-2.8 μ, ellipsoid, oblong or in some cases allantoid in one view or with a slight lateral protrusion (causing the spore to be slightly angular), hyaline in KOH singly, in masses pinkish buff; in Melzer's sol. distinctly amyloid when young, at maturity non-amyloid, wall slightly thickened at maturity and dingy yellow brown in Melzer's sol., basal scar inconspicuous.

Basidia 6-8-spored, hyaline, thin-walled, readily collapsing, 10-16 × 4-5 μ. Paraphyses 16-25 × 10-18 μ, thin-walled, hyaline, readily collapsing. Tramal plates of interwoven hyaline non-gelatinous hyphae 2-6 μ in diam.; subhymenium revived poorly but apparently filamentous. Peridium basically a trichodermium of hyphae with rusty-fulvous walls mostly thickened somewhat, the cells in the layer up to 25μ broad and about isodiametric to elongated (the layer appearing cellular as a result), at the outer surface the hyphal ends more or less projecting or the tips crooked and coiled around each other, the cells versiform (many odd shapes) and smooth-walled, septate. Clamp connections present at the septa regularly on the colored hyphae of the peridium. All tissues non-amyloid.

Found clinging to the sides of an overhanging rocky cliff among rhizomes of *Adiantum pedatum*, Friday Harbor, Washington, *Zeller 1360* type (NY).

Section Amylopogon sec. nov.

Sporae amyloideae.
Typus: *Rhizopogon subpurpurascens* Smith

RHIZOPOGON SUBPURPURASCENS sp. nov.

Fructificationes 1-4 cm latae, globosae vel irregulares, fibrillosae, albidae tactu rubescentes. Gleba olivacea; locelli minuti, globosi, vacui. Sporae 7-8.5(9) × 3-3.5 μ, oblongae vel ellipsoideae, amyloideae. Basidia 6-8-spora, 12-20 × 5-7 μ, tenui-tunicata. Peridium uni-stratosum. Typus: *Smith 65398,* 16 Juli 1962, Stanley, Idaho, U.S.A. (MICH).

Gastrocarp 1-4 cm broad, globose to irregularly compressed, surface dry, white, felty-fibrillose and with appressed rhizomorphs overall, when handled staining slowly brownish and finally dull purplish red (no yellow stage present at any time in the natural sequence of color changes), when dried dark purplish-fuscous overall. Gleba olivaceous, cavities minute.

Peridium bluish with $FeSO_4$. Peridium slowly olive-fuscous with KOH.

Spores 7-8.5(9) × 3-3.5 μ, narrowly oval to oblong, broadest part toward apex in some, many irregular in shape, some 10-11 × 2-2.5μ and curved, some with a lateral protuberance (pistol-grip type), wall thickened slightly, surface faintly mottled as seen under the best oil immersion (1.3 N.A.), appearing smooth under ordinary magnifications, many spores dark violet in Melzer's sol. and some of these dark violet only over the upper part or half with the remainder hyaline; in many the deposition of the amyloid material is seen to be on the line separating the endo- from the exo-sporium; many spores apparently remaining non-amyloid; hyaline individually in KOH but yellowish in masses along the hymenium.

Basidia 6-8-spored, 5-7μ in diam., cystidia none. Paraphyses all thin-walled, oval to subglobose, 12-20 × 8-12μ, the walls very indistinct in KOH, with 1-3 isodiametric cells below to give a cellular subhymenium. Tramal plates of gelatinous interwoven hyphae diverging to subhymenium and enlarged at the septa to 8-10 μ, walls thin, hyaline smooth. Peridium of appressed more or less cylindric hyphae 4-10 μ diam. which are hyaline, thin-walled and smooth, many hyphae with yellowish incrustations on the walls to the point of discoloring the hypha, with a purplish-vinaceous color between the hyphae; consisting of only a single layer. Clamp connections absent. All tissues non-amyloid.

In a group near *Pinus contorta* and *Abies lasiocarpa,* Iron Creek, Stanley, Idaho, coll. Nancy Jane Smith (*A.H.Smith 65398*).

Section Villosuli sec. nov.

Peridium brunneo-villosulum vel tomentosum, demum areolatum.
Typus: *Rhizopogon villosulus* Zeller

RHIZOPOGON VILLOSULUS Zeller, Mycologia 33:2. 1941.

Gastrocarps small, 8-15 mm in diam., subglobose, arising from a large rhizomorph; surface soft, slightly villose, brown (bister) when fresh, changing but little in drying, often becoming areolate due to the rupture of the peridial epicutis, also the latter easily removed by abrasion. Gleba light brown drying buffy brown (dingy avellaneous in the type); cavities small and labyrinthiform. Columella absent.

Spores 6-8 × 2-2.5μ, oblong or nearly so, in KOH hyaline or nearly so, in masses dingy ochraceous to dingy pinkish buff, in Melzer's sol. hyaline individually and in aggregations pale reddish brown, smooth, basal scar inconspicuous. Basidia 6-8-spored, more rarely 4-spored, 15-20 × 4.5-6μ, subcylindric, readily collapsing. Paraphyses septate, terminal cell ovate, obovate to clavate, 15-25 × 7-12μ, mostly with mucilaginous thickenings both in the terminal cell and those beneath it (2-3), the paraphyses readily disarticulating at the septa and then are found floating separately in the mount, the amorphous central body not coloring in Melzer's sol. Tramal plates of highly refractive gelatinous hyphae more or less interwoven; the subhymenium cellular and the cells thickening as indicated above as well as separating at the septa readily under pressure. Peridium duplex: Epicutis of loosely interwoven smooth brown-walled (near cinnamon brown) hyphae with somewhat thickened walls, the hyphae branched and often enlarged near the septa, some with short branches but these not thornlike, very few flagellate hyphae seen; the inner thick layer of interwoven hyphae hyaline in KOH but with dull brown pigment pockets present and in KOH becoming dark green in places, no red pigmentation observed, no pockets of distinctly inflated cells present. Clamp connections absent.

In duff under conifers, Hat Point, above Imnaha, Oregon, Helen M. Gilkey, June 26, 1939, type (NY).

Section Megasporae sec. nov.

Sporae 12-20μ longae, versiformes.

Typus: *Rhizopogon variabilisporus* Smith.

RHIZOPOGON VARIABILISPORUS sp. nov.

Fructificationes 2-4 cm latae, globosae vel irregulares, fibrilloso-scabrosae, pallidae demum vinaceo-brunneae, in siccati atrobrunnis. Gleba "bister" (sordide luteo-brunnea), siccata atrobrunnea. Sporae 20 × 5μ, subcylindricae; 14 × 7.5μ, ovoideae; 12 × 6, angulari-ovatae, pallide "bister" (luteo-brunneae). Peridium unistratosum. Typus: *Smith 66083,* Payette Lakes, Idaho, U.S.A. (MICH).

Gastrocarp 2-4 cm broad, globose to ovoid or angular from pressure; attached by a cluster of basal rhizomorphs; surface rough and fibrillose, ground color whitish but fibrils soon dingy vinaceous brown and much dirt adhering to surface, when dried blackish brown. Gleba near "bister" when cut (dark yellow-brown), slowly darkening to olive brown, about concolorous with peridium in dried state, chambers minute and nearly empty. Odor none. Columella none.

Spores versiform, 20 × 5μ and subcylindric, 14 × 7.5μ and ovoid, 12 × 8μ and obcordate, 14-16 × 7-8μ and clavate, 18 × 6μ and allantoid, some 12 × 6μ and angular-ovate, also in above patterns some may show constrictions or protuberances or be merely somewhat angular in outline; pale bister in masses in KOH, dull brownish singly, yellow brown in Melzer's sol. but with a thin hyaline (mucilaginous ?) sheath, basal scar obscure. Basidia 1-6-spored, spores sessile, basidia often with somewhat thickened walls but not colored like the spores), cylindric to clavate, 6μ or 8-12μ at apex, 15-30μ long, often irregular in shape. Paraphyses resembling basidia. Cystidia none. Tramal plates of interwoven highly refractive cells, and the cellular basal cells of the hymenial elements arise from there. Peridium 1 mm thick, pallid when cut and not discoloring readily (dark brown in drying out), interior containing enlarged cells scattered and in pockets and their walls mostly slightly thickened, filamentous hyphae vinaceous in KOH and with incrusting debris, no epicutis differentiated but numerous hyphal tips project and these heavily incrusted but the walls not appreciably colored (fresh mounts in H_2O), the walls of hyphae near the surface hyaline to pale bister as revived in KOH. Clamp connections none. All tissues nonamyloid.

Gregarious in duff under spruce, Payette Lakes, Idaho, Aug. 21, 1962, *Smith 66083.*

Section Fulviglebae sec. nov.

Gleba cinnamomea, fulva, vinaceo-brunnea vel umbrino-brunnea, vel tactu lutescente.

Typus: *Rhizopogon exiguus* Zeller

RHIZOPOGON EXIGUUS Zeller, Mycologia 31:2. 1939.

Gastrocarp 2-10 mm broad, globose or nearly so, lobed in large specimens, consistency soft and spongy; surface smooth, white with ochraceous mottling, becoming snuff brown, fibrils scanty above, rhizomorphic below. Gleba white then brown (concolorous with peridium as dried in mature specimens) cavities small, rounded, partly filled with spores. Odor farinaceous.

Spores 7-8 x 5-5.5 μ , oval to elliptic and base truncate from a broad basal scar, yellowish individually as revived in KOH and rusty cinnamon in mass, in Melzer's sol. yellowish to rusty yellowish, wall smooth and slightly thickened. Basidia 20-40 x 6-7.5 μ , narrowly clavate, walls often slightly thickened and refractive, 4-spored, sterigmata distinct and walls may be thickened slightly as well as colored pale cinnamon (revived in KOH). Paraphyses 14-20 x 7-10 μ, hyaline, thin-walled, non-gelatinous. Cystidia none. Tramal plates of hyaline refractive hyphae, not obviously gelatinous, subparallel to interwoven, subhymenium of branched filaments. Peridium a single layer of compactly interwoven hyphae, in mass bright rusty cinnamon in KOH, at the exterior with loosely interwoven hyphae yellowish in KOH but not forming a distinct epicutis, hyphae thin-walled or walls very slightly thickened. Clamp connections absent. All tissues nonamyloid.

In heavy duff under hemlock, Pierce County, Wash., *S. M. Zeller 8278* type (NY).

Section Rhizopogon

Gleba white to olive buff, olive or olive-brown.

Typus: *Rhizopogon luteolus* Fr. & Nordh.

R. luteolus is a European species and it remains to be proven that it actually occurs in our flora here in North America.

TRACHEID LENGTHS OF MICHIGAN JACK PINE DETERMINED BY THE LADELL METHOD OF MEASUREMENT

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Tracheids, a characteristic cell type of the huge and diverse division (phylum) of the plant kingdom, Tracheophyta, are the most abundant xylem elements in coniferous wood. These cells, which are non-living, are especially common in pines, firs, spruces, larches, and hemlocks — common and familiar forest trees of North America. In eastern white pine, for example, tracheids account for over 90% of

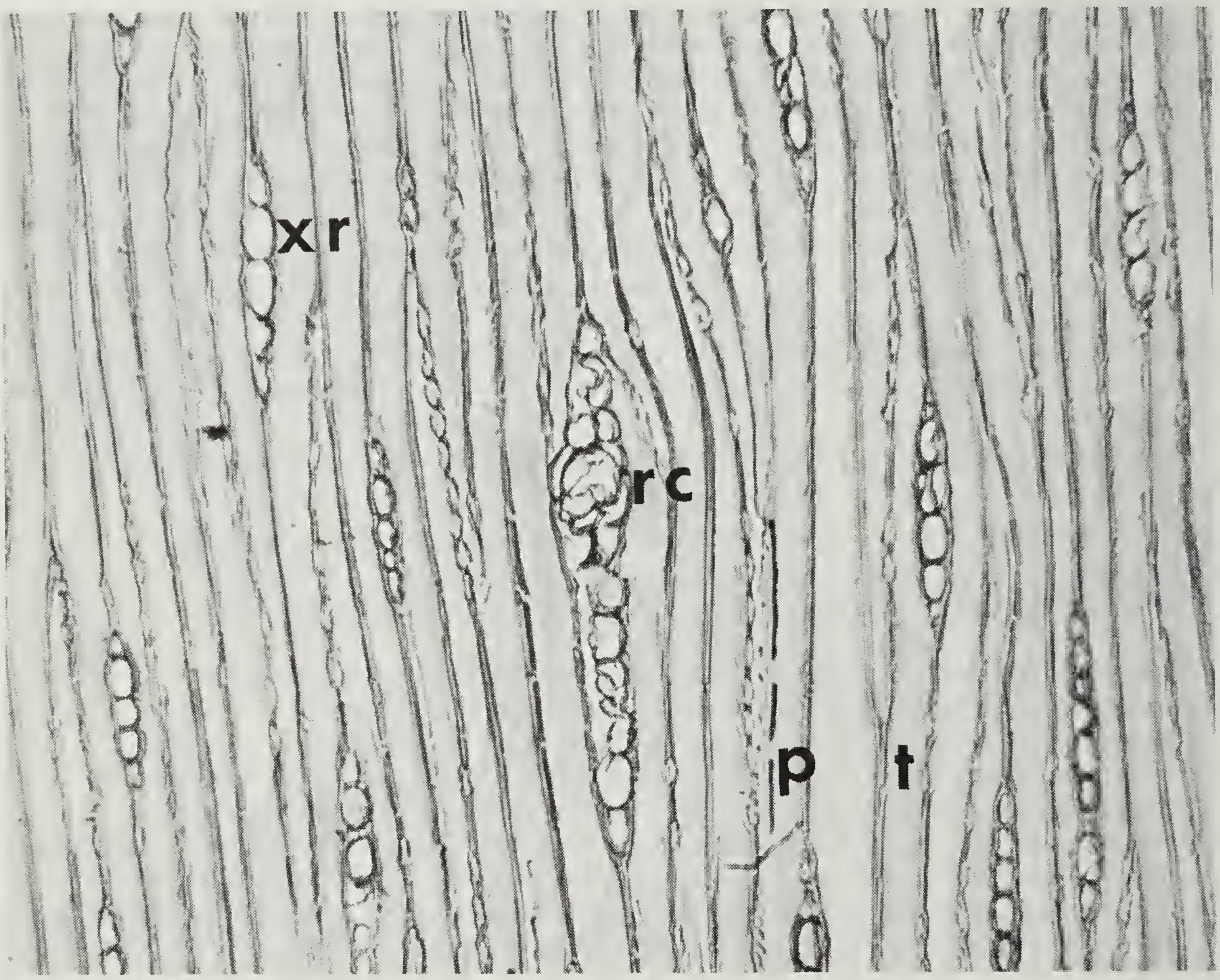

Fig. 1. Photomicrograph of a tangential section of ***Pinus banksiana*** wood, at about 260 x magnification. Letters are at the right of each of the following xylem elements:

xr	xylem ray (uniseriate)	p	pits (an edge view) that are common to two tracheids
rc	resin canal transverse) incorporated in a biseriate xylem ray	t	tracheid tip

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[1] National Science Foundation Undergraduate Research Participant and Associate Professor of Forestry, respectively. This project was supported in part by NSF-G15879 and G22880.

the volumetric composition of the wood. Longitudinal tracheids of the gymnosperms usually range between 2.0 and 5.5 millimeters in length and 25 to 80 microns in width. An individual tracheid is a long rectangular or prismatic cell that abruptly tapers at both ends. Tracheid walls, cross-laminated systems of cellulose fibrils impregnated by lignin, form a sealed hollow tube that is embossed with a series of membranous bordered pits, which allow fluids to pass from one tracheid to another. (See fig. 1.)

These extremely strong woody cells, cemented in tissue-series, provide rigid support in the stems of plants that allows them to stand erect — in trees, up to heights of 50 meters or more. In addition to this mechanical function, a "sapwood" zone of tracheids near the cambium layer plays a vital physiological role in translocating water with its dissolved gases and minerals from the roots to the leaves of a plant.

After the invention of the papermaking machine in 1799, a critical shortage of raw materials developed when the supply of herbaceous plant fibers and papermaking rags of cotton, wool, or linen threads could no longer meet the growing demands of the new paper industry. Fortunately, in the mid-19th century the discovery was made that an abundant and suitable papermaking fiber could be obtained from chemically or mechanically macerated wood. As pulp and paper technology became more sophisticated, it was learned that certain coniferous species contained longer tracheids which when processed into pulpwood produced stronger paper. Today, the wood technologist is constantly measuring and testing samples of tracheids to find the optimum length for any particular paper product.

Measuring tracheid lengths in masses of macerated xylem is a long and tedious operation (Dinwoodie, 1961). Several visual-projection techniques (Echols, 1958, 1959; Kribs, 1928) have shortened measurement time, but these and other previous methods require the separation of individual tracheids by maceration. Recently, a new method (Ladell, 1959) has been devised that greatly reduces measurement time if only the mean length of tracheids is called for. This technique, which employs ratios of cell numbers and dimensions, utilizes tangential sections of unmacerated xylem tissue. Broken and scattered tracheids are thus eliminated, and any particular measurement area can easily be found again. The method is best adapted to coniferous species characterized by short tracheids, especially the genus *Pinus*.

The notes which follow describe the use of Ladell's method in measuring average lengths of tracheids of 25- to 30-year-old jack pine (*Pinus banksiana* Lamb.) from Michigan's Lower Peninsula.

MATERIALS AND METHODS

Four trees, selected at random, were felled on 18 January 1963 in each of the natural stands listed below:

County	Township	N. Lat.	W. Long.	Age	Average Ht. m.	Average dbh cm.
Crawford	Grayling	44°41'29"	84°49'50"	25-30	10.21	15.48
Huron	Port Austin	43°58'12"	83°11'59"	28-31	10.36	11.89
Iosco	Au Sable	44°25'06"	83°21'02"	30-32	10.52	20.32
Mason	Branch	43°56'39"	86°06'30"	25-30	10.36	15.24

Cylindrical, full-diameter samples about 15 cm. long were cut from four sections of each tree: at the base of the lower, second, and third quarters and at the tip of the upper quarter. Tangential sections (16 μ thick) were microtomed from blocks of the 1962-spring wood of the foregoing segments and stained in safranin "O"-fast green. In addition, several comparative blocks of spring and summer wood were treated in Jeffrey's macerating solution (Echols, 1961) to obtain individual tracheid measurements to compare to the mean obtained by using the following formula of Ladell (1959):

$$\overline{T} = \frac{N\,d}{c_n}$$

Where: $\overline{T}$ = mean tracheid length of run
N = number of cells per run
d = distance between upper and lower edge of run
c_n = number of cell tips

A run consists of 20-30 contiguous tracheids found between two parallel lines of known interval-distance, the "d" in the formula. The lines should be far enough apart to create a rectangle with the approximate dimensions X (the total width of the contiguous tracheids) by 2/3 X (the height of the tracheid segments between the upper and lower parallel lines). The number of tracheids that terminate within the zone are then noted and entered into the formula. (N.b.: only those tracheids that enter from the upper or lower edge are counted.) A total of 96 runs were observed for Crawford Co. tree-4, and 144 for the tip sections taken from all four areas. Ladell projected the image of the tracheids upon an opaque surface for measurement, as we did in the present study. In addition we also used a 5 $mm.^2$ net reticule eye piece and measured directly to compare recording time.

RESULTS

Mean lengths of tracheids, standard deviations, and analyses of variance for comparisons within tree Crawford-4, and tips of 16 trees from the four counties, are given in Table 1. There was a progressive increase in tracheid length from the sample at 0.20 m. to the tree tip at 7.93 m. in C-4, but a significant difference only at the 5% level between the 7.93 m. and the rest of the sections, and between the 0.20 m. and the 5.49 m. section. After analysis, no significant differences at all were found between the tracheid lengths of the trees within the four geographic areas; these data were based on measurements obtained from the upper quarter terminal sections of the 16 trees. Direct measurement of the macerated tracheids also showed a progressive increase in length in tree C-4, but no difference between geographic areas.

In contrast to the projection method, measurement time was quartered when the ocular reticule was used.

DISCUSSION

Echols (1958) reported a positive correlation between tracheid length and ascending position within Scotch pine (*Pinus sylvestris*) xylem columns. He also observed a progressive decrease in tracheid length from southern to northern latitudes of geographic origin. Our interpretations of within-tree variation are in accord with his, but more collections are needed to determine the geographical variation of *P. banksiana*. In the present study, a region bounded by 1° of latitude and 3° of longitude was sampled.

More pertinent to our study is the paper by Kribs (1928), wherein he described data based on the measurement of 12, 500 individual tracheids from seven trees of Minnesota populations of jack pine. He found a maximum tracheid length of 5. 05 mm., a minimum of 0. 75 mm., and a mean of 3. 20 mm. He also compared the tracheid lengths within these trees, in relation to the age of a given annual ring (from 1 to 85 years), to the height above ground line (1 to 26. 68 m). The mean tracheid lengths in ascending height for the mean thirtieth annual ring were 2.86 mm. at 0.31 m., 3.50 mm. at 3.35 m., 3.80 mm. at 6.40 m. and 3.85 mm. at 9.45 m.

Considering that Kribs' estimates were obtained from a series of smoothed curves (which gave higher than actual values) and that his data were based on older trees, the figures for mean tracheid lengths given in Table 1, although smaller, are comparable. Kribs found an increase in tracheid length with ascending position in most of his specimens, but in some trees (based on adjusted curves) 41 years and older he calculated a leveling-off and even slight decrease in tracheid length as the apex was reached. He also noted, as we did, that the tracheids in the spring wood portion of any particular annual ring were shorter than those in the summer wood.

In his excellent study of Austrian pine (*Pinus nigra*), Scotch pine, and other conifers, Ladell (1963) presented a detailed statistical evaluation of his "cell tip" method. In view of the very high correlation coefficients (r = 0. 910 to 0. 980) which he found between macerated tissue and "cell tip" readings, it will be interesting to compare Ladell's formula and the macerated wood technique on a large scale. The opportunity for such a comparison will come in a few years in a progeny study of *Pinus banksiana* from some 90 widely separated geographic origins, now being initiated by the Lake States Forest Experiment Station and cooperating agencies in the Lake States.

SUMMARY

The Ladell formula

$$\text{"Mean tracheid length} = \frac{\text{Number of cells} \times \text{distance between lines}}{\text{Numbers of cell tips}}\text{"}$$

was used to obtain the mean tracheid lengths of four populations of Michigan jack pine (*Pinus banksiana* Lamb.). Tracheid lengths in tip sections of 16 trees varied between 3.46 and 3.58 mm. with no significant difference between geographic origins. Within tree, from stem base to tip, there was a gradual and significant increase in tracheid length with 2.22 mm. at 0.20 m. and 3.40 mm. at 7.93 m. Measurement time was reduced by 75 per cent or more by using Ladell's method instead of the macerated tissue technique.

ACKNOWLEDGMENTS

The counsel given by Drs. Eldon A. Behr of Michigan State University, and J. L. Ladell of the Ontario Research Foundation in the preparation of this note is gratefully acknowledged.

TABLE 1. Mean tracheid lengths and analyses of variance for selected Michigan jack pine using the Ladell method (1959).

Crawford Co. Tree - 4

Height of sample m.	Mean tracheid length mm.	Standard deviation	Analysis of variance Source	df	ss	ms	F
0.20	2.22[a]	0.480	Between sample	3	4.4266	1.4755	7.3812**
2.74	2.54	1.092	Within sample	92	18.3866	0.1999	
5.49	2.78	0.860	Total	95	22.8132		
7.93	3.40	1.016					

[a]Duncan's multiple range test significances at 5% level.
**Significant at 1% level.

Tips of 16 trees from Crawford, Huron, Iosco, and Mason Counties

County	Mean tracheid length mm.	Standard deviation	Source	df	ss	ms	F
Crawford	3.24	0.222	Between stands	3	0.0738	0.0246	1.76 NS
Huron	3.58	0.204	Within stands	12	0.1676	0.0140	
Iosco	3.46	0.078	Total	15			
Mason	3.58	0.356					

LITERATURE CITED

Chalk, L., and M. Ortiz C. 1961. Variation in tracheid length within the ring in *Pinus radiata* D. Don. Forestry 34: 119-124.

Dinwoodie, J. M. 1961. Tracheid and fibre length in timber. A review of the literature. Forestry 34: 125-144.

Echols, Robert M. 1958. Variation in tracheid length and wood density in geographic races of Scotch pine. Yale Univ. School of Forestry. Bull. No. 64. 52 pp.

————. 1959. The ampliscope—an instrument for wood-fiber measurements. Jour. Forestry 57: 43-44.

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Kribs, David A. 1928. Length of tracheids in jack pine in relation to their position in the vertical and horizontal axes of the tree. Univ. Minnesota Agr. Exp. Sta. Tech. Bull. 54. 14 pp.

Ladell, J. L. 1959. A new method of measuring tracheid length. Forestry 32: 124-125.

————. 1963. Needle density, pith size and tracheid length in pine. University of Oxford, Commonwealth Forestry Institute, Institute Paper No. 36. 76 pp.

MICHIGAN PLANTS IN PRINT

New Literature Relating to Michigan Botany

The aim of this section is to list all significant literature relating to Michigan botany published since the beginning of 1960, without attempting much coverage of related fields such as agriculture, conservation, and forestry. When the subject matter or relation to Michigan is not clear from the title, annotations are added in brackets.

A. MAPS, SOILS, GEOGRAPHY, GEOLOGY

Under this heading we periodically list new maps of use to field naturalists, as well as selected bulletins and articles on soils and geology of the region, as these may be of value in interpreting plant distribution ecologically or historically.

The following topographic maps for Michigan have been published by the U. S. Geological Survey, Washington, D. C. 20242, since the previous listing in the September, 1962, issue. All of these are 7-1/2 minute quadrangles (scale of 1:24,000 or about 2 inches to a mile) and are supplied with green overprint showing woodland areas (unless request is made to the contrary). Maps may be ordered from the Survey at $ .30 each (20% discount on orders for $10.00 or more). Following the name of the quadrangle, the county in which it primarily lies is added in brackets in the list below:

Augusta (revised) [Kalamazoo]
Avoca [St. Clair]
Banfield (rev.) [Barry-Kalamazoo-Calhoun]
Battle Creek (rev.) [Calhoun]
Bedford (rev.) [Barry-Calhoun]
Bellevue (rev.) [Calhoun-Eaton-Barry]
Brockway [St. Clair]
Brown City [Sanilac-St. Clair]
Burr Oak [St. Joseph-Branch]
Capac [St. Clair]
Ceresco (rev.) [Calhoun]
Clayton [Lenawee]
Clear Lake [Hillsdale, & Indiana & Ohio]
Colon [St. Joseph-Branch]

Delton (rev.) [Barry-Kalamazoo]
Galesburg (rev.) [Kalamazoo]
Jeddo [Sanilac-St. Clair]
Lakeport [St. Clair]
Nettle Lake [Hillsdale, & Ohio]
Nottawa [St. Joseph]
Pioneer [Hillsdale, & Ohio]
Roseburg [Sanilac-St. Clair]
Ruby [St. Clair]
Sturgis [St. Joseph]
Yale [Sanilac-St. Clair]

Franzmeier, D. P., E. P. Whiteside, & M. M. Mortland. 1963. A chronosequence of podzols in northern Michigan: I. Ecology and description of pedons; II. Physical and chemical properties; III. Mineralogy, micromorphology, and net changes occurring during soil formation. Quart. Bull. Mich. Agr. Exp. Sta. 46: 2-57. [Study on areas of different post-glacial ages in Emmet and Cheboygan counties.]

Hough, Jack L. 1962. Lake Stanley, a low stage of Lake Huron indicated by bottom sediments. Geol. Soc. Am. Bull. 73: 613-619. [Evidence for a stage contemporary with Lake Chippewa in the Lake Michigan basin.]

Hough, Jack L. 1963. The prehistoric Great Lakes of North America. Am. Sci. 51: 84-109. [Concise summary of modern interpretation of development and post-glacial history of the Great Lakes, with many maps.]

Kelley, Robert W. 1962. Michigan's Sand Dunes — A Geologic Sketch. Mich. Dept. Conservation. 22 pp. [General information, with map showing location of dunes and sand strips in Michigan.]

Kunkle, George R. 1963. Lake Ypsilanti: A probable late Pleistocene low-lake stage in the Erie basin. Jour. Geol. 71: 72-75. [Evidence (from deposits in Washtenaw Co.) suggesting a low-water stage in the deeper eastern end of Lake Erie during the Cary-Port Huron interval.]

(Michigan State University, Institute for Community Development, Continuing Education Service) 1963. The Proposed Pictured Rocks National Lakeshore - An Economic Study. National Park Service. 67 pp. [The economic data are preceded by sketchy information on history, geology, etc., and (with maps) land ownership and use.]

Odell, R. T., et al. 1960. Soils of the North Central Region of the United States. Wis. Agr. Exp. Sta. Bull. 544. North Central Regional Publ. 76. 192 pp. + map. [A general summary of soils, their distribution and properties, for the 12 states from Michigan and Ohio west to North Dakota and Kansas. Useful descriptions, illustrations, and charts. (Michigan portion of the large folded map of major soils is apparently adapted from Schneider & Whiteside.) Available from the Agricultural Experiment Stations in the 12 states: Michigan residents should order NCR-76 from MSU Bulletin Office, 10 Agriculture Hall, East Lansing. Price $2.00.]

Pincus, Howard J., ed. 1962. Great Lakes Basin. Am. Assoc. Advancem. Sci. Publ. 71. 308 pp. [Symposium, including articles on geology, waters, land use, recreation, etc. $7.50]

C. JOURNAL ARTICLES

Adams, Preston. 1962. Studies in the Guttiferae. I. A synopsis of Hypericum section Myriandra. Contr. Gray Herb. 189: 1-51. [Michigan is included in the stated distribution of *H. kalmianum*, *H. prolificum*, & *H. ellipticum*, but only exact citation is one for *H. kalmianum*.]

Anderson, Dennis E. 1961. Taxonomy and distribution of the genus Phalaris. Iowa State Jour. Sci. 36: 1-96. [Maps & selected citations show occurrence of *P. arundinacea* and *P. canariensis* in Michigan.]

Barkley, T. M. 1963. A revision of Senecio aureus Linn. and allied species. Trans. Kansas Acad. 65: 318-408. [Maps & selected citations include several Michigan species: *S. aureus*, *S. obovatus*, *S. pauperculus*, *S. plattensis*, *S. indecorus*.]

Bigelow, Howard E., & Margaret E. Barr. 1962. Contribution to the fungus flora of northeastern North America. II. Rhodora 64: 126-137. [Several of the Basidiomycetes & Ascomycetes mentioned are said to occur in Michigan, usually without specific citations.]

Brooks, Travis E., & Donald T. Kowalski. 1963. A preliminary survey of the Myxomycetes of Emmet and Cheboygan counties. Pap. Mich. Acad. 48: 131-136.

Clevenger, Sarah, & Charles B. Heiser, Jr. 1963. Helianthus laetiflorus and Helianthus rigidus—hybrids or species? Rhodora 65: 121-133. [Distribution maps include Michigan occurrences of *H. subrhomboideus*, *H. rigidus*, *H. × laetiflorus*, & *H. tuberosus*.]

Cooke, W. Bridge. [1961]. The cyphellaceous fungi a study in the Porotheleaceae. Sydowia, Ann. Mycol. II, Beih. 4: xv + 144 pp. [The distributions given for several species include Michigan, usually with no further locality data.]

Cooper, Arthur W. 1960. A further application of length-width values to the determination of leaf-size classes. Ecology 41: 810-811. [A sampling study done at the George Reserve, Livingston Co.]

Curtis, E. J. C., & J. E. Cantlon. 1963. Germination of Melampyrum lineare: Interrelated effects of afterripening and gibberellic acid. Science 140: 406-408. [Laboratory studies on plants grown from seed from Crawford Co.]

DeLisle, Donald G. 1963. Taxonomy and distribution of the genus Cenchrus. Iowa State Jour. Sci. 37: 259-351. [Map & selected citations show distribution of *C. longispinus* in Michigan.]

Ebinger, John E. 1962. Validity of the grass species Digitaria adscendens. Brittonia 14: 248-253. [Generalized distribution map shows *D. sanguinalis*, not *D. adscendens*, in southwest Michigan.]

Forman, Richard T. T. 1962. The family Tetraphidaceae in North America: Continental distribution and ecology. Bryologist 65: 280-285. [Map includes Michigan distribution of the moss *Tetraphis pellucida*.]

Getz, Lowell L. 1960. A population study of the vole, Microtus pennsylvanicus. Am. Midl. Nat. 64: 392-405. [Introduction includes brief description of vegetation in old field and marsh study areas in University of Michigan Mud Lake Research Area, Washtenaw Co.]

Getz, Lowell L. 1961. Factors influencing the local distribution of shrews. Am. Midl. Nat. 65: 67-88. [Includes descriptions and tables for vegetation in 7 habitats in Mud Lake Research Area, Washtenaw Co.]

Getz, Lowell. 1961. Notes on the local distribution of Peromyscus leucopus and Zapus hudsonius. Am. Midl. Nat. 65: 486-500. [Includes structural diagrams, with symbols modified from Dansereau, for 15 habitats in Mud Lake Research Area, Washtenaw Co.]

Gilbert, Elizabeth F. 1961. Phenology of sumacs. Am. Midl. Nat. 66: 286-300. [Studies on *Rhus glabra* and *R. typhina* in Washtenaw Co.]

Godman, Richard M., & Laurits W. Krefting. 1960. Factors important to yellow birch establishment in Upper Michigan. Ecology 41: 18-28. [Study area is not located other than "Upper Michigan."]

Goldstein, Solomon. 1960. Degradation of pollen by Phycomycetes. Ecology 41: 543-545. [Observations in Washtenaw Co.]

Gould, Frank W. 1963. Cytotaxonomy of Digitaria sanguinalis and D. adscendens. Brittonia 15: 241-244. [An 1838 Kalamazoo Co. collection has exceptionally large pollen for *D. sanguinalis*.]

Green, Peter S. 1962. Watercress in the New World. Rhodora 64: 32-43. [Map and citations show occurrence in Michigan of *Rorippa nasturtium-aquaticum*, *R. microphylla*, & *R. ×sterilis*.]

Hale, Mason E., Jr. 1963. Populations of chemical strains in the lichen Cetraria ciliaris. Brittonia 15: 126-133. [Maps show occurrence of all three strains in Michigan.]

Haynes, Dean L., & James W. Butcher. 1962. Studies on the ecology of European pine shoot moth larvae in Michigan. Ecology 43: 96-107. [Includes data on growth of pines with infected shoots.]

Heatwole, Harold. 1962. Environmental factors influencing local distribution and activity of the salamander, *Plethodon cinereus*. Ecology 43: 460-472. [Includes environmental data (soil, temperature, general vegetation, etc.) from beech-maple forest in Emmet Co. and oak-pine-aspen stand in Cheboygan Co.]

Helmich, Darlene E. 1963. Pollen morphology in the maples (*Acer* L.). Pap. Mich. Acad. 48: 151-164. [Some of the pollen studied for several of the species was from Michigan specimens.]

Henderson, Norlan C. 1962. A taxonomic revision of the genus Lycopus (Labiatae). Am. Midl. Nat. 68: 95-138. [Maps show distribution in Michigan of *L. uniflorus, L. americanus, L. rubellus,* & *L. asper.*]

Hermann, F. J. 1962. Additions to the bryophyte flora of Keweenaw County, Michigan. Rhodora 64: 121-125.

Hesterberg, Gene A. 1963. Recent pathological problems of Michigan's coniferous plantations. Pap. Mich. Acad. 48: 21-30. [Current status of several important fungal diseases of forest trees.]

Hiltunen, Jarl K. 1962. Rediscovery of the wall-rue in Michigan. Brittonia 14: 120. [Occurrence of this fern on Drummond Island. See also Mich. Bot. 1: 25-26 (1962).]

Horton, James H. 1963. A taxonomic revision of Polygonella (Polygonaceae). Brittonia 15: 177-203. [Map shows occurrence of *P. articulata* in Michigan.]

Hunt, George S. 1963. Wild celery in the lower Detroit River. Ecology 44: 360-370. [Study of *Vallisneria* in relation to various factors, including pollution.]

Iltis, Hugh H. 1963. Napaea dioica (Malvaceae): Whence came the type. Am. Midl. Nat. 70: 90-109. [Includes Michigan distribution of *Sida hermaphrodita.*]

Kadlec, John A. 1961. A further comment on the ecology of woolgrass (*Scirpus cyperinus*). Ecology 42: 591-592. [Study of establishment of seedlings, compared with cattails, on exposed mudflats in Roscommon Co.]

Kadlec, John A. 1962. Effects of a drawdown on a waterfowl impoundment. Ecology 43: 267-281. [Discussion of effects on vegetation in Roscommon Co.]

Kilburn, Paul D. 1963. Exponential values for the species-area relation. Science 141: 1276. [Includes calculations and graph based on jack pine stand in "Lower Michigan," apparently Cheboygan Co.]

Korf, Richard P. 1962. A rare North American discomycete, together with some comments on the genus *Lachnellula*. Trans. Mycol. Soc. Japan 3: 47-50. [Refers to an earlier Washtenaw Co. collection of the rare *L. theiodea.*]

Koyama Tetsuo. 1963. The genus Scirpus Linn. Critical species of the section Pterolepis. Canad. Jour. Bot 41: 1107-1131. [Cities *S. olneyi* from Michigan.]

Mandossian, Adrienne, & Robert P. McIntosh. 1960. Vegetation zonation on the shore of a small lake. Am. Midl. Nat. 64: 301-308. [Duck Lake, near Kellogg-Gull Lake Biological Station of Michigan State University, Kalamazoo Co.]

Martin, G. W. 1962. Taxonomic notes on Myxomycetes, IV. Brittonia 14: 180-185. [Includes description of a new species, *Physarum dictyosporum*, from Cheboygan Co.]

Maycock, Paul F. 1961. The spruce-fir forests of the Keweenaw Peninsula, northern Michigan. Ecology 42: 357-365. [Four upland stands (precisely located!) studied ecologically in Keweenaw Co.]

Mazzer, Samuel J., & A. J. Sharp. 1963. Some moss reports for Michigan. Bryologist 66: 68-69. [Brief notes on 3 species new to state and 3 rare ones.]

Moore, R. J., & C. Frankton. 1963. Cytotaxonomic notes on some Cirsium species of the western United States. Canad. Jour. Bot. 41: 1553-1567. [Includes count of 2n = 34 on material of *C. pitcheri* from Emmet Co.]

Oltz, Donald F., & Ronald O. Kapp. 1963. Plant remains associated with mastodon and mammoth remains in central Michigan. Am. Midl. Nat. 70: 339-346.

Piehl, Martin A. 1962. *Holosteum umbellatum L.,* an angiosperm new to Michigan. Rhodora 64: 222-225. [Several collections and observations from Washtenaw Co.]

Rogers, C. Marvin. 1963. Yellow flowered species of Linum in eastern North America. Brittonia 15: 97-122. [Distribution maps include Michigan counties for *L. sulcatum, L. catharticum, L. medium, L. virginianum* & *L. striatum.*]

Schelske, Claire L., Frank F. Hooper, & E. J. Haertl. 1962. Responses of a marl lake to chelated iron and fertilizer. Ecology 43: 646-653. [Study on the Sand Lakes, Grand Traverse Co., included effects on photosynthesis and phytoplankton.]

Shaffer, Robert L. 1962. The subsection Compactae of Russula. Brittonia 14: 254-284. [5 species (3 of them new) and 1 new form are cited from Michigan.]

Sherff, Earl Edward. 1962. Further notes on the distribution of Bidens connata vars. pinnata and gracilipes. Rhodora 64: 23-28. [Complete Michigan data for var. *gracilipes* (3 counties).]

Smith, Alexander H. 1960. Tricholomopsis (Agaricales) in the Western Hemisphere. Brittonia 12: 41-70. [Michigan collections cited for several of the species, but usually without further locality data.]

Smith, Alexander H., & L. R. Hesler. 1962. Studies on Lactarius—III. The North American species of section Plinthogali. Brittonia 14: 369-440. [15 species (11 of them new) and 10 new varieties cited from Michigan.]

Soper, James H., & Paul F. Maycock. 1963. A community of arctic-alpine plants on the east shore of Lake Superior. Canad. Jour. Bot. 41: 183-198. [Distribution maps include Lake Superior records in Michigan for *Woodsia alpina, Polygonum viviparum, Sagina nodosa,* & *Saxifraga aizoon.*]

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Sparrow, Frederick K. 1961. Observations on Chytridiaceous parasites of phanerogams—X. Notes on some species of Physoderma occurring in the Douglas Lake region of northern Michigan. Pap. Mich. Acad. 46: 183-194. [Observations (including two new species) from Cheboygan and Emmet counties.]

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PROGRAM NOTES

MICHIGAN BOTANICAL CLUB

February 22 - March 1, Cobo Hall, Detroit. Southeastern Chapter has its annual exhibit and sales booth at the builders' and flower show. (Note that there is also another flower and garden show on the same dates in the Coliseum Building at the State Fair Grounds.)

March 15: State Meeting, in Ann Arbor. Details later.

May 29 (Friday evening) - May 31 (Sunday noon): Spring Campout, at the Conservation Training School, Higgins Lake.

In the future: Plans are already underway for the 1965 MBC Spring Campout, which will be in the Upper Peninsula during the long four-day Memorial Day weekend.

EDITORIAL NOTES

COMING: In the next two or three issues, we expect to include (among other articles) the remainder of Dr. Crum's important checklist of mosses, a report on prairie vegetation on Harsen's Island (St. Clair Co., Michigan), some new or interesting records of vascular plants from Michigan, and notes on distribution patterns of some familiar wild flowers.

WANTED: Short notes and observations, as well as longer articles, are welcomed, as is news of botanists and botanical activites in the Upper Great Lakes region (research, field trips, appointments, etc.).

The previous number (Vol. II, No. 4), was mailed October 23, 1963.

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THE MICHIGAN BOTANIST

March, 1964

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Articles and notes relating to any phase of botany in the Upper Great Lakes region are welcomed; manuscripts should be sent to the editor in chief. Subscriptions and inquiries regarding them (from those not members of the Michigan Botanical Club) should be sent to the circulation manager, who will assume that subscriptions received prior to the last number of a volume are intended to begin with the first number of that volume unless specified to the contrary.

Manuscripts intended for publication should be neatly typed, double-spaced, carefully prepared and checked for accuracy before submission, as our method of printing does not include a proof which can be sent to authors. Follow the style of recent issues, especially in regard to references. In determining suitability of material for publication, the editors and reviewers must consider the wide diversity of botanical interests among our members and subscribers and seek appropriate clarity and precision. Authors of more than two pages of print in an issue will receive, if requested in advance, five copies of that issue. Reprints may be ordered at cost.

THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora and to establish suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Inquiries regarding membership may be directed to the state secretary or, from those residing where there is a chapter, to the appropriate chapter secretary. (The Southeastern Chapter is centered in the Detroit metropolitan area; the Huron Valley Chapter, in Washtenaw County; and the Northwestern Chapter, in the northwestern Lower Peninsula.) Dues are modest, but vary slightly among the chapters; in all cases, they include subscription to THE MICHIGAN BOTANIST.

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BLACK CROWBERRY IN THE LAKE SUPERIOR REGION

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and Herbarium, The University of Michigan, Ann Arbor

Attention has been focussed recently on the distribution and affinities of some of the distinctive shoreline plants of the Great Lakes region (Guire & Voss, 1963). A factor responsible for part of the continuing current interest in the phytogeography of this area has been the completion in September, 1960, of the Lake Superior portion of the Trans-Canada Highway (Soper, 1963). The subsequent increase in botanical exploration has resulted in the appearance in several herbaria of collections from areas around the north shore of Lake Superior which previously had been difficult to reach.

Among the shoreline species, some are truly arctic-alpine and their occurrences in the Great Lakes region are usually limited to the north shore of Lake Superior, with perhaps an additional isolated station on the Keweenaw Peninsula of the south shore. The absence of collections and reports for such species from the shores of the other Great Lakes suggests that only Lake Superior has a large enough body of cold water with shoreline habitats sufficiently similar in soils, exposures, and climate to those in which the species in question thrive in the arctic. In some cases, one site may contain a whole community of northern species (Soper & Maycock, 1963). Few truly northern species are found as far south as the sandy southeast shores of Lake Superior but one noteworthy example in this category is the Black Crowberry (*Empetrum nigrum* L.).

Empetrum nigrum was collected by Louis Agassiz in 1848 during his famous expedition by canoe along the north shore of Lake Superior. The occurrence of various arctic species at such comparatively southern latitudes (47^o to 49^o N.) was reported as one of the most interesting discoveries made by the expedition (Agassiz, 1850).

Black Crowberry is a prostrate, trailing or low mat-forming evergreen with short flattish leaves somewhat resembling those of a conifer. (Fig. 1.) Its flowers are tiny, inconspicuous, solitary or few in the axils of the leaves and maturing into blue-black to purplish-black edible berry-like fruits. In this region there is considerable variation and intergradation in those vegetative characteristics, such as the pubescence and glandularity of stems and leaves, which have been used to distinguish *Empetrum nigrum* from *E. atropurpureum* Fern. & Wieg. Butters and Abbe (1953, pp. 171-172) called attention to the presence in the Lake Superior region of individuals corresponding to both species, and reported both of them from Cook County in easternmost Minnesota. More recently, Löve and Löve (1959) maintained that *E. nigrum* is strictly a European species and that North American plants previously referred to it should actually be called *E. hermaphroditum* (Lange) Hagerup. Soon afterwards, D. Löve (1960) reduced both *E. hermaphroditum* and *E. atropurpureum* to subspecific status under the older name, *E. eamesii* Fern. & Wieg., and called attention to apparent hybrids between the subspecies.

We might therefore be justified in referring all Lake Superior plants to the single variable species, *E. eamesii;* but as still further investigations on the problem in Newfoundland and the Maritimes are being conducted (D. Löve, personal communication to E.G.V.), we are retaining, at least temporarily, the more familiar broad concept of *E. nigrum.* The present notes are intended to comment on the known distribution of Crowberry in this region and not to settle a complex taxonomic problem. Preliminary studies by Robert L. Jeanne, made at the suggestion of the junior author, have demonstrated relatively little correlation, in several Lake Superior collections, among the characteristics which supposedly distinguish two taxa; if they are distinct, even as subspecies as proposed by Löve, there is evidently considerable introgression. We hope that these notes will call attention to the need for more critical collecting and for further study of the problem in this area.

Empetrum nigrum has been found at many localities around Lake Superior (see Fig. 2), at the shore or within one or two miles of it. The plant occurs most frequently on rocky shores just above the water line reached during heavy storms, there growing on rock ledges, in rock crevices, at the edges of rock pools, or on cool sphagnum-covered rocks. Such are its most frequent habitats on the north shore, including Isle Royale. At slightly inland sites it may occur in bogs or muskegs. On the south side of Lake Superior, where it is less abundant, the collections are from white-cedar and black spruce bogs (Keweenaw Peninsula), the barren dolomitic sandstone summit of a cliff above Lake Superior (Pictured Rocks), and on moist sandy banks

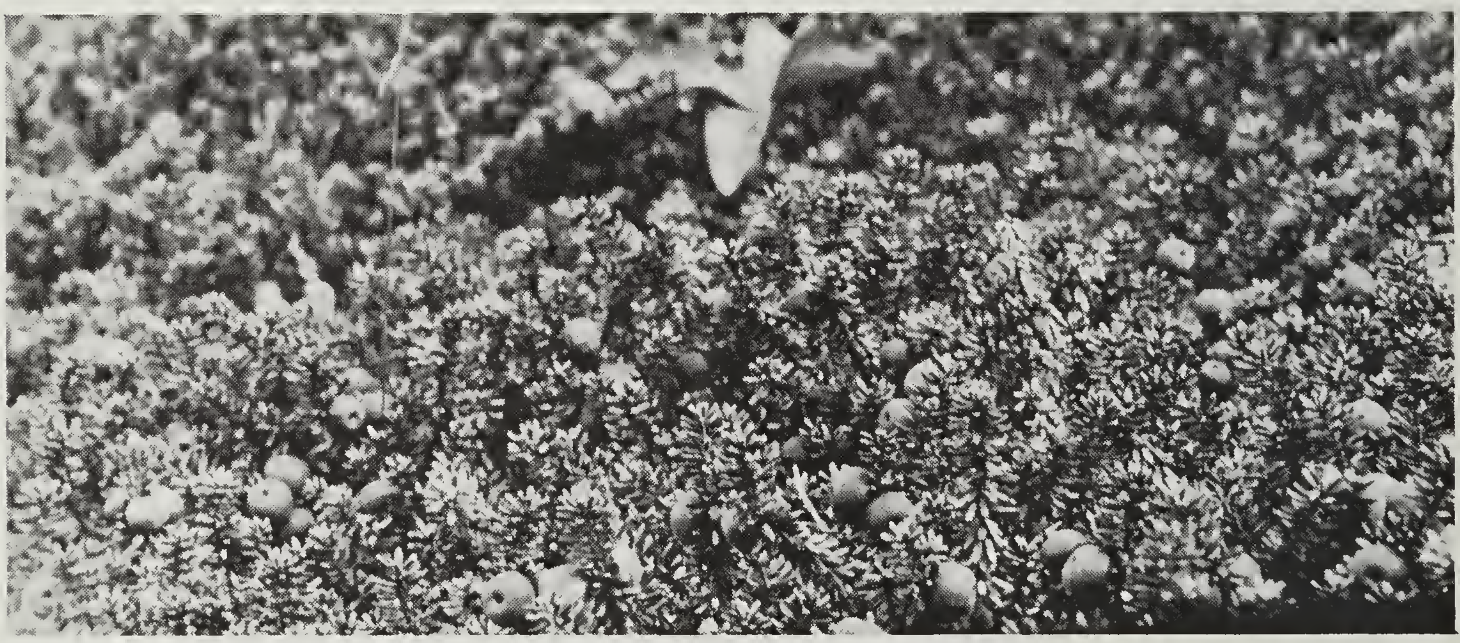

Fig. 1. *Empetrum nigrum.* (Photographed by Wm. Randolph Taylor, 31 August 1920, E. shore of Seal Cove, Mt. Desert Island, Maine.

along the lakeshore (east of Deer Park). This sandy habitat may seem unusual, but at the southernmost locality on the east shore (Agawa Bay) the species grows in sand partly shaded by *Pinus resinosa* at the upper edge of a wide beach of sand and cobblestones (*Soper 9642A,* TRT); and much farther north, on the sandy upper beach of a bay near Angler (3 miles NW of Marathon), there is an extensive mat of *Empetrum* growing in full sun with *Lathyrus japonicus* in stabilized places (*Voss & Jeanne 10437,* MICH, TRT).

North of Lake Superior, the Crowberry has been collected on the east side of Lake Nipigon and at many places on or near the shores of James Bay and Hudson Bay (see Fig. 2). The common habitats in the arctic and subarctic region are bogs, muskegs, sphagnum hummocks, sandy beach ridges, and rocky shores. *Empetrum nigrum,* in the traditional sense, is circumpolar and widely distributed across

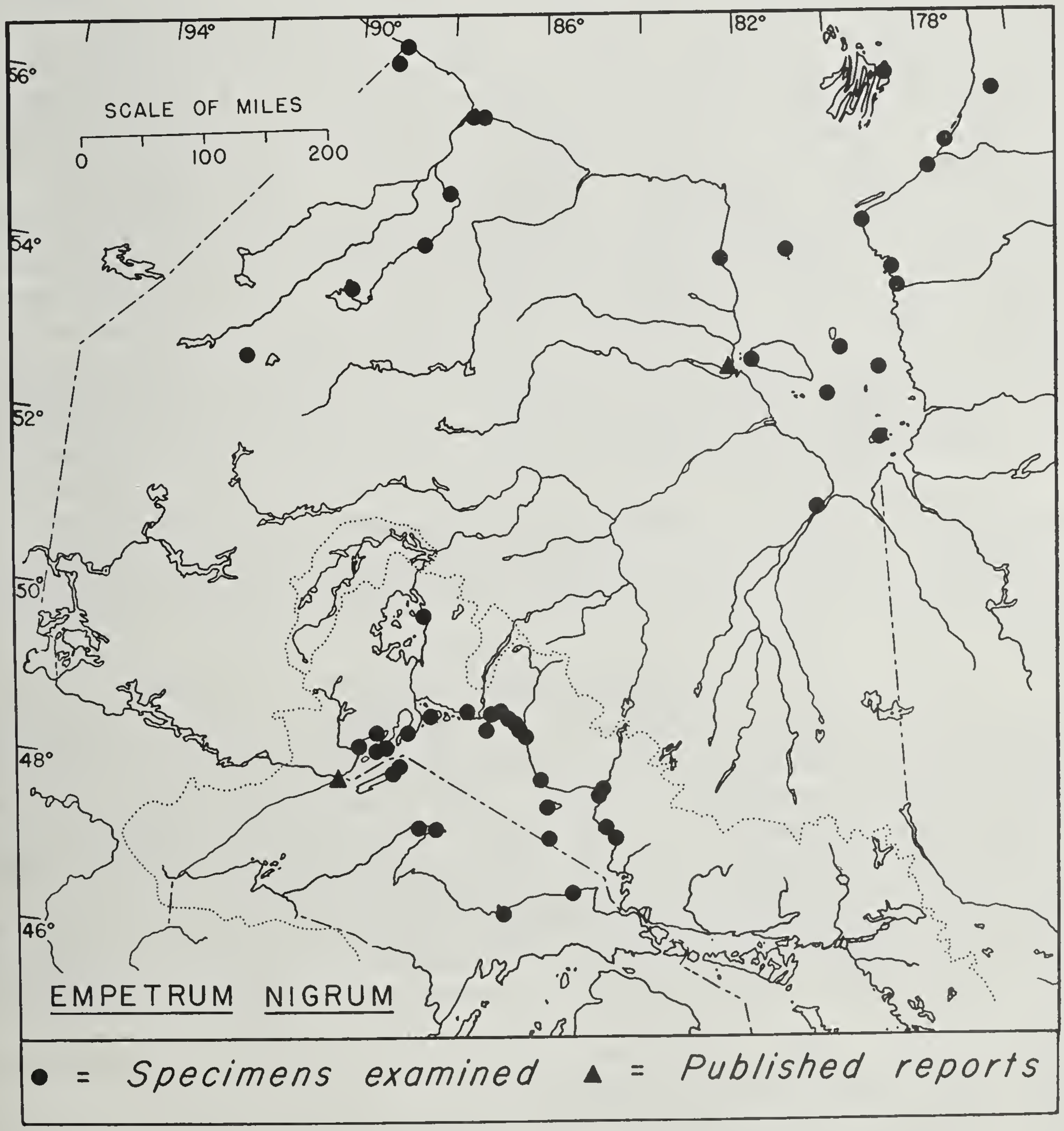

Fig. 2. Distribution records for *Empetrum nigrum*, sens. lat., in in the Lake Superior — Hudson Bay region.

the American Arctic from Greenland to Alaska (see Porsild, 1957, map 255). In the eastern part of North America it occurs southward to the coast of Maine and is isolated at high elevations on mountains in New York state and New England.

The following list cites the more southerly records plotted on the map, i.e. these in the southeastern half of Lake Superior, chiefly south of 48° N. latitude. The map is based on specimens in the following herbaria (supplemented, as indicated on the map, by published records): University of Toronto (TRT), University of Michigan (MICH), National Herbarium of Canada (CAN), and the private herbarium of Mr. Claude E. Garton, Port Arthur. The gaps between the known stations along the eastern half of the north shore largely reflect the lack of collections from areas still not accessible by road.

ONTARIO: THUNDER BAY DIST.: island E. of La Canadienne Pt., 8 Aug. 1931, *C. O. Grassl 458* (MICH); West Sand Bay, Michipicoten Is., 1 Aug. 1931, *C. O. Grassl 462* (MICH). ALGOMA DIST.: Entrance Is., Michipicoten Hbr., 1 Aug. 1938, *R. C. Hosie et al. 1252* (TRT); Brule Bay, 3 Aug. 1939. *R. C. Hosie et al. 1253* (TRT); S of mouth of Coldwater River, 5 Aug. 1961, *Voss & Jeanne 10589* (MICH, TRT); Agawa Is., 18 July 1931, *C. O. Grassl 461* (MICH); S end of Agawa Bay, 21 June 1963, *J. H. Soper 9642 A* (TRT); Caribou Is., 30 July 1931, *C. O. Grassl 463* (MICH). MICHIGAN: KEWEENAW CO.: bog S of Schlatter L., 28 June 1949, *C. D. Richards 2212 A* (MICH); *Thuja* bog southeast of Eagle Harbor, 21 July 1936 *F. J. Hermann 8196* (MICH). ALGER CO.: top of Miner's Castle, Pictured Rocks, 1888, *G. H. Hicks* (MICH); 11 Aug. 1934, *F. J. Hermann 6337* (MICH). LUCE CO.: Moist sandy banks along shores of Lake Superior, "Deer Park and westward," *C. A. Davis* in 1905 (MICH) [Davis' notes are more explicit than his label, and even contradictory: "On sandy shore (fixed dunes) just above storm waves and along borders of the woods at foot of dunes between the mouth of Two Hearted River and Deer Park." This would be *east* of Deer Park.]

A very old collection in the herbarium of the University of Toronto (TRT #8231) appears to be an original specimen from the Agassiz expedition of 1848. It is labelled "Lac Superieur. Agassiz" but without statement of exact locality. It may well be the earliest collection of Crowberry from the Lake Superior region.

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RECORDS OF MICHIGAN VASCULAR PLANTS, WITH PRIMARY REFERENCE TO THE MACKINAC STRAITS REGION[1]

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Floristic botany in the Mackinac Straits region has had a long history with the result that this has become one of the better known areas in the upper Midwest. Pioneer botanical explorations are reported to have begun with Thomas Nuttall, who, in 1810, was the first botanist known to collect in the region. Additional 19th century explorations and plant collections were made by Douglass Houghton, N. H. Winchell, E. J. Hill, Charles F. Wheeler, C. W. Fallass, and others.

With the establishment in 1909 of the University of Michigan Biological Station on Douglas Lake, near the boundary between Emmet and Cheboygan counties, the number of observations and collections increased. An annotated list and supplements to it were published by Gates and Ehlers between 1925 and 1948. More recently, Voss (1954) compiled a checklist of the vascular plants for the two-county Douglas Lake region, to which additional information, including a detailed history of floristics in the area, has been added (Voss, 1956, 1957). In addition to these major studies are the observations and collections of numerous Biological Station teachers, researchers, students, and visitors, some of them specialists on particular groups, which have contributed considerably to the thoroughness with which the area has been covered.

For an area rich in botanical activities it seems well to place on record a few new observations. Since these are based solely on my own collections, they are not to be considered a complete list of species new or rare in the region, as other collectors may well have additional records. Both my observations for the Mackinac Straits region and those from elsewhere in the state were made incidental to other field work in connection with graduate studies during the summers of 1958, 1959, and 1960. In the preparation of this report, I have consulted the herbaria at the University of Michigan, the Biological Station, Cranbrook Institute of Science, Michigan State University, and for *Geocaulon,* the Gray Herbarium of Harvard University. Voucher specimens are at the University of Michigan Herbarium unless otherwise noted.

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[1] Contribution from the University of Michigan Biological Station.

[2] I am indebted to Ronald L. Stuckey for considerable help with the manuscript and checking herbarium records.

Asplenium platyneuron (L.) Oakes Ebony Spleenwort

Cheboygan Co.: Open aspen woods immediately south of Biological Station campus and overlooking Burt Lake, 16 August 1958, *Piehl 58284*.

Although only a single frond was collected from the one large plant found (a search for others was unsuccessful), this fern was no longer in evidence when the author revisited the site in 1960. Isolated, single specimens have been found several times in Michigan according to data given with some of the specimens in the University of Michigan Herbarium, although the species characteristically forms populations of several to many plants in other regions. The occurrence of widely scattered, and probably short-lived individuals is of interest, since the species is at the northern limits of its range. This plant has previously been recorded from scattered localities in the southern part of the Lower Peninsula, and Hagenah (1955) has reported a single locality from Chippewa County in the Upper Peninsula. The scattered distribution pattern in Michigan suggests comparatively long distance spore dispersal.

Anthoxanthum odoratum L. Sweet Vernal Grass

Cheboygan Co.: Moist soil along Carp Creek at the "Gorge" near the Biological Station, 21 June 1958, *Piehl 58154* and *A. E. Schuyler 70* (UMBS[3] acc. to Schuyler). Naturalized from Europe, this species was previously known in the region only from a Fallass collection made in 1925 near Conway, Emmet County.

Stipa spartea Trin. Porcupine Grass

Mackinac Co.: Open calcareous soil along road near shore, Point Aux Pins, Bois Blanc Island, 2 Aug. 1958, *Piehl 58274*.

This collection is of interest because this grass is known in the region only from the island and one locality in northern Alpena County. Taken from approximately the same site as an earlier island collection (*Ehlers 4849*, MICH), it supplies evidence that this population has probably persisted for at least 30 years. The plants in the sizeable stand from which my specimen was taken bore numerous mature fruits, which because they adhere well to fibrous materials and are classic examples of a hygroscopic, self-planting mechanism, would give the species a high potential for spreading on the island and elsewhere.

Lilium philadelphicum L. forma *flaviflorum* E. F. Williams Wood Lily

Presque Isle Co.: In sod along U. S. Highway 23, 19 mi. east of Cheboygan in the Hammond Bay area, 8 July 1960, *Piehl 6060*.

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[3] Herbaria are designated by abbreviations routinely used in taxonomic work and given in Lanjouw & Stafleu, *Index Herbariorum* (1959).

This single specimen with distinctly yellow flowers occurred with the typical red to orange flowered form. The perianth segments were bright yellow with red or rufous spots on the claw. Only one previous collection, from Drummond Island, Chippewa County (*McVaugh 9103*, MICH), is known for Michigan. McVaugh indicated on the label that his specimen was also a single plant in a population of the typical form.

Cypripedium calceolus L. var. *pubescens* (Willd.) Correll
Moccasin Flower

Cheboygan Co.: On sphagnum in small opening of conifer swamp ("Reese's Bog") near north end of Burt Lake, 7 July 1958, *Piehl 58231.*

This material is unusual in that its entire foliage is variegated. The leaves are light yellow with narrow lines of green running from the apex toward the base, giving the plant a rather spectacular appearance. Some of the green lines run entirely to the leaf base, others just part way. In other respects the plant resembles the typical form. Such variants, rather common in both monocots and dicots and often cultivated for their foliage, are said to be caused by virus infections and other pathogens (C. W. Bennett, Yearbook of Agriculture, *Plant Diseases*, pp. 15-26. 1953). Similar variegated specimens have sometimes been recognized taxonomically at the *forma* level (e.g., by MacKeever, 1961); however, it seems that these variants, particularly if they are induced by pathogens, are of relatively little taxonomic significance.

Geocaulon lividum (Richardson) Fernald Northern Comandra

Presque Isle Co.: In sand of former shoreline of Lake Huron near conifers, 8 July 1960, *Piehl 6054*; and at a similar site 23 mi. northwest of Rogers City between U. S. Highway 23 and Lake Huron, 9 Sept. 1960, *Piehl 60113*. Cheboygan Co.: Edge of conifers near shore at Grass Bay, ca. 4.5 mi. east of Cheboygan, 30 May 1960, *Piehl 6045*; and among open conifers on low, stabilized beach dunes, Cordwood Point, 29 July 1960, *Piehl 6078*. Charlevoix Co.: Among conifers along U. S. Highway 31, 4 mi. south of the town of Bay Shore, 8 Sept. 1960, *Piehl 60109*.

These new localities serve to locate what appear to be the southern limits of the present range of the species in Michigan, which is at the southern boundary of its total range. It was previously known in the Lower Peninsula (and nearby islands of the Straits) from Beaver, Bois Blanc, and Mackinac Islands, the Waugoshance Point area (including Cecil and Sturgeon Bays), Reese's Bog (Cheboygan County), and near Tawas City (Iosco County). The two latter sites are of interest because Reese's Bog is an inland station (all others are on or near the shores of the Great Lakes) and the Tawas locality is the southernmost report for the state. The author visited both of these sites in 1958 and 1960 in search of *Geocaulon,* but no specimens could be found. This species is also relatively uncommon in the Upper Peninsula.

One collection made on Isle Royale by Clover in 1959 and given to the author includes some variegated specimens in which the chlorotic areas follow the veins to form a reticulate pattern. Observations of material from over a large part of the range of the species indicate that such specimens are proportionately more common in northern Canada and Alaska.

Polygonum cuspidatum Sieb. & Zucc. Japanese Knotweed

Eaton Co.: Forming a large stand 6 ft. tall in abandoned access road to clay pit, Grand Ledge, 24 Oct. 1959, *Piehl 59801.*

This suffrutescent species with large (for *Polygonum*), cordate leaves and winged sepals like those of *P. convolvulus,* was introduced from Asia and grown as an ornamental. My observations indicate it escapes rather often and therefore is probably much more widespread in nature than the few records from Emmet, Oakland, Washtenaw, and Wayne counties would suggest.

Penthorum sedoides L. Ditch Stonecrop

Cheboygan Co.: Several plants on muddy, open streamside along state highway 33 just north of railroad crossing near Mullett Lake (sec. 8, T 36 N, R 1 W), 11 Aug. 1960, *Piehl 6083.*

Apparently this is the only collection from the region now substantiated by specimens. Voss (1956) reports that the Beardslee and Kofoid record published by Beal and Wheeler (1892) and later by Beal (1905) is not supported by voucher specimens. This species is known from Menominee and Houghton counties in the Upper Peninsula, and in the Lower Peninsula is rather common, particularly southward. It is to be expected elsewhere in the Mackinac Straits region.

Euphorbia polygonifolia L. Seaside Spurge

Menominee Co.: In drifting sand on Lake Michigan shore, Menominee County Park along state highway 35, 25 Aug. 1958, *Piehl 58317.*

This shoreline species was previously known from the Atlantic coast and around the lower four Great Lakes but not from the northern shore of Lake Huron in Ontario and the Upper Peninsula shore of Lake Michigan. The collection cited here constitutes a new record of the species for the Upper Peninsula, although it is known from the Door Peninsula of Wisconsin. (See maps in Wheeler, 1941; Guire and Voss, 1963.)

Orobanche uniflora L. One-flowered Broom-rape

Presque Isle Co.: Under conifers along U. S. Highway 23, 0.9

mi. south of Hoeft State Park (near Rogers City), 8 July 1960, *Piehl 6057.*

This non-green parasite on the subterranean parts of Compositae and perhaps other angiosperms is rather local in distribution and was included among the species reported as " rare" in the region by Voss (1949). It is also known from near the shore of the Mackinac Straits, Emmet County, and from Beaver and Mackinac Islands.

Lactuca muralis (L.) Gaertn. Wall Lettuce

Mackinac Co.: Along beach near Lake Shore Road on southwest side of Mackinac Island, 20 July 1958, *Piehl 58255.*

Although early collected on Mackinac Island, this species is not known from elsewhere in Michigan. It should be searched for in other parts of the Straits region, since it has persisted on the island for some years and produces readily disseminated air-borne fruits. Radloff (1961) reports that it is now known from very scattered localities in the northern United States and adjacent parts of Canada, and that it is not common at any of these.

Lactuca saligna L. forma *ruppiana* (Wallr.) G. Beck
Willow-leaved Lettuce

Washtenaw Co.: Open forest of mixed hardwoods between Cedar Bend Drive and North Campus, Ann Arbor, 1 Oct. 1959, *Piehl 59781.*

The only representative of the species in Michigan, this form was collected once previously in the state near Ypsilanti, Washtenaw County (*Hermann 6972,* MICH, MSC, US; see Hermann, 1936). Radloff, who has verified my identifications in this genus, believes this *Lactuca* is often overlooked because of its slender, straggly habit (personal communication).

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THE MICHIGAN LILY

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Apparently at no time since Farwell originally described it as a species new to science, in 1915, has anyone discussed the occurrence of the "Michigan Lily," *Lilium michiganense,* within its home state of Michigan.

Oliver A. Farwell, botanist for Parke, Davis & Company, described *L. michiganense* as "unquestionably a distinct species" from the related wild lilies with nodding flowers, the Wild Yellow or Canada Lily (*Lilium canadense*) and the Turk's-cap Lily (*L. superbum*). The locality cited in the original description is "Wiard's Crossing" [3 mi. E. of Ypsilanti, Washtenaw Co.], Michigan, which is thus the type locality. At the same time, Farwell (1915, pp. 352-354) described *L. michiganense* variety *umbelliferum*, which differed in having the inflorescence an umbel of 2-5 flowers; and var. *uniflorum*, with a solitary flower. Typical *L. michiganense* was described as having "flowers in a pyramidal cluster (two to four axial from the uppermost whorl and about four racemosely disposed on the terminal portion of the stem". Furthermore, he described as a distinct species *L. peramoenum,* differing in more numerous leaves and flowers. The type locality of the latter species is "Parkedale Farms" [near Rochester, Oakland Co.], Michigan.

Farwell had not only a keen eye for variation but also a penchant for giving scientific names to plants which most presentday taxonomists would consider trivial, or individual, variations. (See McVaugh, Cain, & Hagenah, 1953.) *Lilium michiganense* is the only one of the species described as new by him which is generally accepted by botanists today. (A great many of his varieties, subvarieties, forms, etc., are also not now widely recognized.) After referring to Farwell's var. *uniflorum* and *L. peramoenum*, Steyermark (1963, p. 432) states: "I have considered such differences in numbers of flowers and leaves as varying responses to the amount of moisture in the soil as well as age and vigor of the individual plant, and as not meriting recognition.'' It is suggestive that Farwell (1915, p. 354) described his robust *L. peramoenum* from '' elder thickets in rich muck lands,'' stating that *L. michiganense* '' is found usually in poorer soil though it may be in dry fields and on banks or in wet swamps and meadows.''

However, agreement is not universal among botanists in recognizing the distinctness of *L. michiganense*. Apparently all of our native lilies with nodding flowers in Michigan do belong to only one species, notwithstanding various reports in the past which have called it *L. superbum* or *L. canadense*, as well as *L. michiganense*. Although I have not personally had field experience with the two former species where they grow, I am quite willing to concur in the judgment of Steyermark, who in the most recent summary regarding *L. michiganense* (loc. cit.) affirms that '' in the main it shows fairly stable characters by which it can be recognized both in the field and herbarium''.

Superficially, *L. michiganense* strongly resembles the Turk's-cap Lily, *L. superbum*, in having at maturity very strongly recurved tepals (undifferentiated petals and sepals)—well shown in our cover picture. The current manuals by Gleason and Cronquist consider these species synonymous. But on numerous characteristics, these species do seem to be distinct (see Mohlenbrock, 1962). For example, my measurements on herbarium specimens of *L. michiganense* reveal anther lengths ranging from 4.5 to 12 mm (or rarely 17 mm). In *L. superbum* , the anthers are longer (reported to range from 11 or 17 mm to 25 mm). In *L. michiganense*, the margins and veins on the underside of at least the middle and lower leaves are scabrous or sharply papillose, and the midvein on the back of the tepals is more or less low and rounded; in *L. superbum*, the leaves are nearly always smooth and the back of the tepals is sharply ridged or acute.

In the characteristics cited for *L. michiganense* (shorter anthers, scabrous leaves, rounded midvein of tepals), as well as additional ones (see Boivin & Cody, Steyermark), there is little if any consistent difference from the Canada Lily, *L. canadense*. About the only reliable distinction (besides a tendency for straighter stamen filaments) in *L. canadense* is the slightly arching (not recurved) tepals. But a few (perhaps still young) flowers of *L. michiganese* may appear to have only arching tepals.

Both the Canada and Turk's-cap Lilies range well to the east and south of the upper Great Lakes region. The Midwest species, *L. michiganense*, occurs from southern Ontario, Michigan, Wisconsin, and Minnesota south to Tennessee, Arkansas, and Kansas. Our only other native lily is the familiar Wood Lily (*L. philadelphicum*), which is easily distinguished by its erect flowers, rather straight tepals narrowed to a basal ''claw,'' and smooth leaves on the veins beneath. As the fruit (a capsule) of the Michigan Lily matures, the stalk does become erect, but there is still usually a slight irregularity a short distance below the capsule, suggestive of the former nodding position of the flower.

As the distribution map (Fig. 1) shows, this species is apparently absent from the eastern portion of the Upper Peninsula. A number of species have a generally similar distribution—occurrence in the Lower Peninsula, where rare or absent northward, and then again in the western Upper Peninsula. Presumably such a distribution is due more to historical factors (spread of the species from farther south

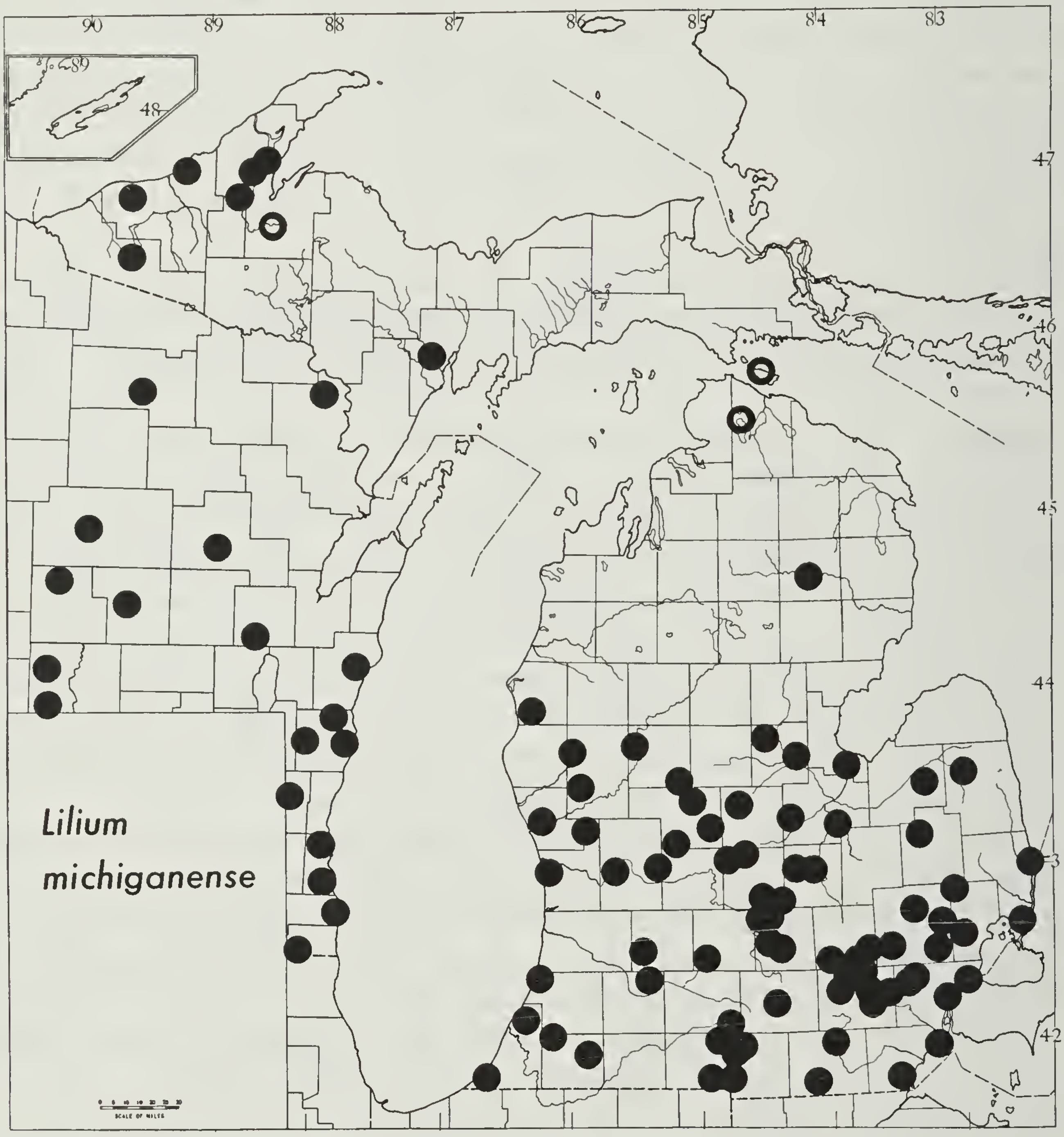

Fig. 1. Distribution of *Lilium michiganense* in Michigan and adjacent Wisconsin. Wisconsin records from McIntosh (1950). Solid circles in Michigan represent specimens examined in herbaria at The University of Michigan, Michigan State University, Cranbrook Institute of Science, and Wayne State University. Open circles in Michigan represent three records (discussed in the text) for which specimens have not been seen. In addition, there are reports for every county bordering Michigan and Lake Michigan in Ohio, Indiana, and Illinois. The higher frequency of dots in some well known areas represents greater abundance of collectors, not necessarily greater abundance of the species.

since glaciation) than to absence of required habitat or other environmental conditions. Among the other species displaying a general distribution pattern of this type in Michigan are the Hornbeam or Ironwood (*Carpinus caroliniana*), Box-elder (*Acer negundo*), Sessile-leaved Bellwort (*Uvularia sessilifolia*), and sedges such as *Carex grayi, C. hirtifolia, C. sprengelii,* and *C. woodii.*

Two reports from the Mackinac Straits region are unsupported by specimens. C. K. Dodge (1921, p. 32) listed "*L. superbum*" from "Rich open or slightly shaded ground on north side of Bois Blanc Island, Mackinac County. Apparently infrequent." An old report from Reese's Bog at the north end of Burt Lake, Cheboygan Co., has been discussed previously (Voss, 1956, p. 55). The species is presumably now extinct at this site, which is a well studied area near the University of Michigan Biological Station. Dr. Eric A. Bourdo reports (personal communication) that he has collected *L. michiganense* at the Ford Forestry Center, south of L'Anse, Baraga County. These three reports, for which I have not seen specimens, are indicated by open circles on the map.

Lilium michiganense is to be expected in wet meadows, thickets, at the edges of streams and woods, often in partial or deep shade, even in swamp forests and boggy woods. It is one of the handsomest of all our wild flowers, and is generally in bloom by the middle of July. Normally there are from one to five flowers on a plant, but there may be twice as many (or reportedly even more).

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MOSSES OF THE DOUGLAS LAKE REGION OF MICHIGAN[1]

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(Continued from p. 12)

Mnium longirostrum Brid. On rocks and soil. Mackinac Co.: Mackinac I. (Harper).

Mnium stellare Hedw. On the bark of exposed roots or tree bases, also on old logs and stumps, sometimes on soil or rocks. Cheboygan Co.: Carp Creek (Frodin); Gorge of Carp Creek (Wynne; Crum; Nichols); Iron Bridge, Carp Creek (Mazzer); Reese's Bog (Roberts). Emmet Co.: Sturgeon Bay (Feigley). Mackinac Co.: Castle Rock (Koch).

Mnium marginatum (With.) Brid. ex P.-Beauv. [*M. serratum* Brid.] On moist rock or soil on shaded banks in woods, often near streams, or on cliffs, sometimes on humus or logs. Cheboygan Co.: Reese's Bog (Crum); Mill Creek (Wynne; Crum). Emmet Co.: Wilderness State Park (Wagoner); dam, Maple R. (Robinson & Crum). Mackinac Co.: Bois Blanc I. (Wynne); Pointe-aux-Pins, Bois Blanc I. (Steere).

Mnium lycopodioides Schwaegr. On boulders and cliffs, soil or humus of banks, sometimes on logs. Cheboygan Co.: Douglas L. (Nichols); N. Fishtail Bay, Douglas L. (Nichols).

Mnium orthorhynchum Brid. On moist, shaded rocks and cliffs or on soil or humus of banks in woods, often on mounds at the base of trees (rarely on bark of tree bases). Cheboygan Co.: Douglas L. (Nichols); Fairy I., Douglas L. (Nichols); Reese's Bog (Roberts; Gleason; Kubsch); Iron Bridge, Carp Creek (Fulford; Arzeni); Burt L. (Nichols). Emmet Co.: dam, Maple R. (Robinson & Crum; Crum); Cross Village (Mazzer; Frodin); Wilderness State Park (Pagán); Big Stone Bay (Nichols); Cecil Bay (Zwickey).

Mnium spinulosum BSG. On soil or logs and rocks, especially in coniferous woods. Cheboygan Co.: Reese's Bog (Feigley; Sharp; Kubsch); Carp Creek (Pagán); Gorge of Carp Creek (Pagán); Mud L. (Wynne). Emmet Co.: Wilderness State Park (Wagoner). Mackinac Co.: Bois Blanc I. (Wynne); Castle Rock (Koch).

Mnium cinclidioides Hüb. On wet soil, often along streams, in boggy woods or swamps. Cheboygan Co.: Burt L., mouth of Carp Creek (Ikenberry).

Mnium punctatum Hedw. On wet soil, humus, old logs, or rocks in wet places, generally along brooks or in wet depressions in woods or swamps, usually shaded. Cheboygan Co.: Reese's Bog (Roberts; Crum). Mackinac Co.: Pointe-aux-Pins, Bois Blanc I. (Steere).— Var. *elatum* Schimp. In swamps and muddy places in forests. Cheboygan Co.: Gorge of Carp Creek (Pagán; Iron Bridge, Carp Creek (Fulford); Reese's Bog (Wynne). Emmet Co.: Maple R., W. of Pellston (Sharp).

Mnium pseudopunctatum Bruch & Schimp. On wet humus in *Thuja* or spruce bogs and near pools in open fens. Cheboygan Co.: Reese's Bog (Wynne; Sharp; Crum); Mud L. (Sharp). Emmet Co.: Upper Maple R. (Robinson); Cecil Bay (Wynne; Sharp; Steere). Mackinac Co.: Mackinac I. (Wynne).

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Cinclidium stygium Sw. In very wet places, in open fens, near trickling springs, or among sedges near pools, probably limited to calcareous habitats. Emmet Co.: Cecil Bay (Steere; Wynne; Nichols). Mackinac Co.: Bois Blanc I. (Wynne); Pointe-aux-Pins, Bois Blanc I. (Steere). Presque Isle Co.: Hammond Bay (Steere; Nichols).

AULACOMNIACEAE

Aulacomnium androgynum (Hedw.) Schwaegr. On damp, shaded logs and stumps or soil and humus, often on banks. Cheboygan Co.: Carp Creek (Pagán; Nichols); Gorge of Carp Creek (Sharp); Iron Bridge, Carp Creek (Sharp); Burt L. (Nichols & Ehlers). Emmet Co.: Cross Village (Frodin).

Aulacomnium palustre (Hedw.) Schwaeger. Very common and widely distributed, on wet soil, humus, or rock, sometimes on old logs, stumps, or old *Sphagnum* hummocks, in swamps, fens, burned-over bogs, swampy forests, etc. Cheboygan Co.: Douglas L. (Ehlers; Nichols); Carp Creek (Pagán; Crum); Gorge, Carp Creek (Cobbe); Iron Bridge, Carp Creek (Fulford); Reese's Bog (Feigley); Wolff's Bog (Fulford); Maloney's Bog (Kubsch); Livingston's Bog (Kubsch); Bryant's Bog (Roberts); Smith's Bog (Cobbe); Mud L. (Hatcher; Sharp). Emmet Co.: Levering (Ehlers); Wilderness State Park (Crum); Cecil Bay (Wynne); Wycamp L. (Gleason); dam, Maple R. (Robinson & Crum); Stutsmanville (Robinson & Sharp). Mackinac Co.: Rexton (Grassl); Bois Blanc I. (Wynne). Presque Isle Co.: Hammond Bay (Hatcher).

Aulacomnium heterostichum (Hedw.) BSG. Typically on soil of banks in rather dry, open woods, often on the bases of trees, on or among exposed roots, rarely on rocks or logs. Cheboygan Co.: Douglas L. (Nichols).

CATOSCOPIACEAE

Catoscopium nigritum (Hedw.) Brid. A calciphile of wet habitats, typically on peaty humus at the margins of pools in fens and sometimes on bare calcareous mud or limestone cliffs, most often on wet dune sand in the Great Lakes area. Cheboygan Co.: Duncan Bay (Wynne). Emmet Co.: Wilderness State Park (Pagán); Cecil Bay (Steere; Wynne; Rogg). Mackinac Co.: Pointe-aux-Pins, Bois Blanc I. (Steere). Presque Isle Co.: Hammond Bay (Keck); coast guard station, Hammond Bay (Nichols).

MEESIACEAE

Meesia uliginosa Hedw. On wet, often peaty soil in calcareous, usually open, swampy places, frequently also in crevices of wet cliffs or on seepage banks. Cheboygan Co.: Carp Creek (Crum; Steere); Iron Bridge, Carp Creek (Wynne); Duncan Bay (Steere); Cheboygan (Brown). Emmet Co.: Cecil Bay (Wynne). Presque Isle Co.: Hammond Bay (Steere).

Meesia tristicha BSG [*M. triquetra* (Hook. & Tayl.) Ångstr.]. On wet soil or humus in bogs and meadows, often emergent from shallow water. Cheboygan Co.: Mud L. (Nichols; Nichols & Ehlers); Little Lake Sixteen (Nichols; Nichols & Steere).

Amblyodon dealbatus (Hedw.) BSG. On clay or peaty soil and occasionally rocks or logs in wet, calcareous habitats, particularly on banks of streams and seepage slopes and crevices of cliffs. Mackinac Co.: Mackinac I. (Sharp). Presque Isle Co.: Hammond Bay (Steere).

TIMMIACEAE

Timmia megapolitana Hedw. On moist or wet, shaded soil or humus, sometimes on rotten logs, typically along streams, sometimes on shaded banks. Cheboygan Co.: Douglas L. (Nichols); Reese's Bog (Shetler; Nichols); Mill

Creek (Wynne); Black L. (Steere). Emmet Co.: Wycamp L. (Koch); Maple R. (Arzeni). Mackinac Co.: Mackinac I. (Nichols).

BARTRAMIACEAE

Plagiopus oederi (Brid.) Limpr. On or in crevices of damp, shaded cliffs or humus over boulders, generally calciphilous. Mackinac Co.: Mackinac I. (Nichols).

Bartramia pomiformis Hedw. On moist, shaded soil of steep banks in woods and often on ledges, crevices, or faces of cliffs. Cheboygan Co.: Douglas L. (Nichols & Ehlers); Polypody Bluff, Douglas L. (Nichols). Emmet Co.: dam, Maple R. (Robinson & Crum).

Philonotis fontana (Hedw.) Brid. On wet soil or humus, often emergent from shallow water, around springs, in backwater of brooks, roadside ditches, and other wet, usually open places. Cheboygan Co.: Cheboygan (Wynne); Carp Creek (Roberts); Gorge of Carp Creek (Kubsch; Pagán). Emmet Co.: Wilderness State Park (Frodin); Cecil Bay (Wynne). Mackinac Co.: Mackinac I. (Sharp); Bois Blanc I. (Wynne).

Philonotis marchica (Hedw.) Brid. On wet soil, often rocky, beside springs or small streams and in ditches along roads or railroads. Cheboygan Co.: Burt L. (Nichols) — presumably three localities, "near," "east," and "northeast."

ORTHOTRICHACEAE

Orthotrichum obtusifolium Brid. On the bark of trees (commonly on poplars), usually in the open, rarely on old fence rails. Cheboygan Co.: Smith's Bog (Nichols); Carp Creek (Nichols; Pagán); Reese's Bog (Nichols); Mud L. (Crum). Emmet Co.: Stutsmanville (Sharp & Robinson). Mackinac Co.: Mackinac I. (Hermann); Bois Blanc I. (Wynne).

Orthotrichum speciosum Nees ex Sturm var. *elegans* (Hook. & Grev.) Warnst. [*O. elegans* Hook. & Tayl.]. On the bark of trees, occasional on logs or old fence rails. Cheboygan Co.: Carp Creek (Pagán); Reese's Bog (Nichols); Grapevine Pt., Douglas L. (Robinson). Emmet Co.: Pellston (Crum); Cecil Bay Wynne); Wilderness State Park (Robinson); Big Stone Bay (Nichols). Mackinac Co.: Mackinac I. (Nichols); Bois Blanc I. (Wynne); Pointe-aux-Pins, Bois Blanc I. (Steere).

Orthotrichum sordidum Sull. & Lesq. ex Aust. On the bark of trees. Cheboygan Co.: Gorge of Carp Creek (Crum; Pagán); Colonial Pt., Burt L. (Wynne); Mud L. (Crum). Mackinac Co.: Mackinac I. (Cobbe; Nichols); Pointe-aux-Pins, Bois Blanc I. (Steere).

Orthotrichum anomalum Hedw. On rocks, usually if not always calcareous. Emmet Co.: Big Stone Bay (Nichols). Mackinac Co.: Mackinac I. (Nichols).

Orthotrichum ohioense Sull. & Lesq. ex Aust. On the bark of trees. Cheboygan Co.: Reese's Bog (Kubsch); Gorge of Carp Creek (Crum).

Orthotrichum pumilum Dicks. On the bark of trees. Emmet Co.: Pellston (Crum).

Orthotrichum stellatum Brid. On bark of trees, occasionally on old fence rails. Cheboygan Co.: Carp Creek (Bevis).

Ulota ludwigii (Brid.) Brid. On the bark of trees in damp woods. Emmet Co.: Cecil Bay (Wynne). Mackinac Co.: Mackinac I. (Steere).

Ulota crispa (Hedw.) Brid. On the bark of trees, usually in damp woods.

Cheboygan Co.: Carp Creek (Pagán); Gorge of Carp Creek (Wynne); Fontinalis Run (Roberts). Emmet Co.: Pellston (Crum); Cecil Bay (Fulford). Mackinac Co.: Mackinac I. (Wynne); Bois Blanc I. (Kubsch).

FONTINALACEAE

Fontinalis disticha Hook. & Wils. ex Drumm. Attached to roots (and probably other substrata) and submerged in creeks and swamps (apparently in sluggish water). Cheboygan Co.: Pigeon R. (Ehlers).

Fontinalis duriaei Schimp. Attached to roots, logs, twigs, branches, and rocks and submerged in shallow water (probably most often in swift-moving streams). Cheboygan Co.: Smith's Bog (Fulford); Fontinalis Run (Ehlers & Blinks); Carp Creek (Roberts; Pagán; Patterson; Nichols); Iron Bridge, Carp Creek (Fulford; Nichols; Tinney; Gleason; Robertson); Gorge of Carp Creek (Crum; Wynne); Nigger Creek (Ehlers); "creek flowing into Lake Huron" (Shacklette). Emmet Co.: Maple R. (Blanchard); dam, Maple R. (Minert; Phinney); Maple R., near Pellston (Nichols); between Levering and Carp L. (Ehlers); Carp L. (Ehlers). Mackinac Co.: Prentiss Bay (Ehlers).

Dichelyma capillaceum (With.) Myr. On sticks, bases of trees, bushes, and stumps, and sometimes on rocks in swamps and at the edge of brooks and pools, submerged at least at high water. Cheboygan Co.: Carp Creek (Arzeni).

Dichelyma pallescens BSG. On the bases of trees and bushes and on old wood or sometimes rocks, submerged in shallow pools, ponds, or streams at least at high water. Cheboygan Co.: Black L. (Steere).

CLIMACIACEAE

Climacium dendroides (Hedw.) Web. & Mohr. On wet, shaded soil in swamps and wet woods and at the margins of lakes and streams. Cheboygan Co.: Colonial Pt., Burt L. (Nichols); Fontinalis Run (Roberts); Bessey Creek (Robertson); N. Fishtail Bay, Douglas L. (Roberts); Reese's Bog (Fulford; Roberts; Wynne); Carp Creek (Pagán); Iron Bridge, Carp Creek (Fulford); Mud L. (Wynne). Emmet Co.: Upper Maple R. (Robinson); Cross Village (Arzeni); Cecil Bay (Wynne). Mackinac Co.: Bois Blanc I. (Wynne).

HEDWIGIACEAE

Hedwigia ciliata (Hedw.) P.-Beauv. Very common and widely distributed on dry, granitic boulders in the open or in partial shade (in open woods and often in scrubby pastures and at roadsides), rarely on calcareous rocks. Cheboygan Co.: Colonial Pt., Burt L. (Crum; Robinson & Crum; Wynne); Reese's Bog (Hatcher). Emmet Co.: Cecil Bay (Hatcher; Zwickey); Cross Village (Arzeni).

CRYPHEACEAE

Forsstroemia trichomitria (Hedw.) Lindb. [*Leptodon trichomitrion* (Hedw.) Mohr]. On bark of trees, rarely on rock. "Mackinaw," C. F. Wheeler, 1890 (in herb. Michigan State University) — now Mackinaw City, hence near the Cheboygan-Emmet County line.

LEUCODONTACEAE

Leucodon sciuroides (Hedw.) Schwaegr. On the bark of trees in open woods or along roads (rarely also on limestone rocks). Cheboygan Co.: Smith's Bog (Nichols); Carp Creek (Pagán); Gorge of Carp Creek (Kubsch; Crum; Roberts); Reese's Bog (Robinson & Crum); Colonial Pt., Burt L. (Wynne). Emmet Co.: Maple R. (Kubsch). Mackinac Co.: Mackinac I. (Kubsch); Bois Blanc I. (Wynne).

Leucodon julaceus (Hedw.) Sull. Typically on the trunks of trees (but sometimes on the bases or on exposed roots), occasionally on decayed logs and stumps or rocks. Cheboygan Co.: Gorge of Carp Creek (Arzeni).

NECKERACEAE

Homalia jamesii Schimp. Usually on damp, shaded rock (most often at the base of cliffs) and also rather frequently on bark at base of trees. Cheboygan Co.: Grapevine Pt., Douglas L. (Iltis; Steere). Emmet Co.: Wilderness State Park (Feigley).

Neckera pennata Hedw. Typically on the trunks of trees in moist woods, occasionally on logs or rocks. Cheboygan Co.: Carp Creek (Pagân); Gorge of Carp Creek (Crum; Kubsch); Reese's Bog (Roberts; Nichols; Wynne). Emmet Co.: Cross Village (Steere); Good Hart (Kubsch); Cecil Bay (Fulford; Wynne). Mackinac Co.: Mackinac I. (Kubsch); Bois Blanc I. (Wynne); Prentiss Bay (Ehlers). Presque Isle Co.: Presque Isle lighthouse (Wetmore).

FABRONIACEAE

Anacamptodon splachnoides (Froel, ex Brid.) Brid. On the bark of trees, particularly in the protection of crotches, fissures, or knotholes, rarely on logs or stumps. Cheboygan Co.: Colonial Pt., Burt L. (Phillips). Emmet Co.: Cross Village (Keck).

THELIACEAE

Thelia hirtella (Hedw.) Sull. On bark, particularly at the base of trees, sometimes on logs or stumps, rarely on soil or rock. Cheboygan Co.: Fontinalis Run (Roberts).

Myurella julacea (Schwaegr.) BSG. Generally in crevices of shaded, moist cliffs, sometimes on soil at the base of trees or on banks of brooks, apparently preferring calcareous habitats. Cheboygan Co.: near Levering (Kubsch); Bryant's Bog (Nichols); Pine Pt., Douglas L. (Clark). Emmet Co.: Big Stone Creek (Steere); Wilderness State Park (Crum; Shacklette; Wagoner); Cecil Bay (Wynne; Crum). Presque Isle Co.: Hammond Bay (Hatcher).

Myurella sibirica (C.M.) Reim. [*M. careyana* Sull.] Typically in deeply shaded, moist niches and crevices of cliffs, sometimes on protected soil of banks or sides of damp logs, often in calcareous habitats. Cheboygan Co.: Mill Creek (Wynne). Mackinac Co.: Mackinac I. (Kubsch; Shacklette).

Pterigynandrum filiforme Hedw. var. *minus* Lesq. & James. Generally on shaded boulders or cliffs, sometimes on the bark of trees (especially at the base or on exposed roots), rarely on logs or soil at the base of trees. Cheboygan Co.: Douglas L. (Nichols & Ehlers). The only local specimen seen was collected on the base of a maple. No definite locality was given but Nichols (1922) reported the species as "occasional on the roots of trees along a low lake bluff, Bryant's."

LESKEACEAE

Lindbergia brachyptera (Mitt.) Kindb. On the trunks of trees, particularly on roadside elms and maples, occasionally on old logs or fence rails, very rarely on rocks. Cheboygan Co.: Black L. (Steere); NE. of Burt L. (Nichols). Emmet Co.: Sturgeon Bay (Arzeni); Cross Village (Sharp); Larks L. (Sharp); between Levering and Cross Village (Steere). Presque Isle Co.: Hammond Bay (Steere).

Leskeella nervosa (Brid.) Loeske [*Leskea nervosa* (Brid.) Myr.]. On bark, especially on the bases or exposed roots of trees, also frequently on rock and occasionally on rotten logs (probably calciphilous). Cheboygan Co.: Colonial

Pt., Burt L. (Ehlers); Polypody Bluff, Douglas L. (Nichols); Beavertail Creek, (Robinson); Gorge of Carp Creek (Iwatsuki). Emmet Co.: Maple R. (Fulford); Wilderness State Park (Feigley); Cecil Bay (Fulford); Cross Village (Arzeni). Mackinac Co.: Mackinac I. (Hermann).

Pseudoleskeella tectorum (A. Br. ex Brid.) Kindb. ex Broth. [*Leskea tectorum* (A. Br.) Lindb.] On rock of various kinds (or thin soil over rock), less often on logs and stumps or bark at base of trees. Cheboygan Co.: S. Fishtail Bay, Douglas L. (Arzeni).

THUIDIACEAE

Heterocladium dimorphum (Brid.) BSG [*H. squarrosulum* (Voit.) Lindb.]. On soil, humus, or rocks in moist wood, particularly on the steep banks of streams. Emmet Co.: Big Stone Bay (Ehlers).

Anomodon attenuatus (Hedw.) Hüb. On bark of trees (especially at the base), also on logs and stumps, rocks (particularly limestone), and sometimes soil, in rather dry or moist, shady places. Cheboygan Co.: Bryant's Bog (Nichols); Gorge, Carp Creek (Nichols); Fontinalis Run (Roberts); Douglas L. (Ehlers); Mud L. (Pagán); Mill Creek (Wynne). Emmet Co.: Upper Maple R. (Fulford); Carp L. (Gleason). Wilderness State Park (Shacklette); Cecil Bay (Wynne); Big Stone Bay (Nichols & Ehlers); Good Hart (Kubsch). Mackinac Co.: Bois Blanc I. (Kubsch; Wynne); Prentiss Bay (Ehlers).

Anomodon minor (Hedw.) Fürnr. On trunks or bases of trees, sometimes on logs and stumps or on rocks, probably preferring limestone. Cheboygan Co.: Colonial Pt., Burt L. (Wynne; Kubsch); Fontinalis Run (Roberts); Mud L. (Nichols). Emmet Co.: Upper Maple R. (Mazzer); Carp L. (Ehlers); Cross Village (Kubsch); Wilderness State Park (Feigley); Cecil Bay (Nichols & Ehlers). Mackinac Co.: Bois Blanc I. (Wynne).

Anomodon rugelii (C.M.) Keissel. On the bark of trees or stumps (often at the base), sometimes on rocks. Cheboygan Co.: Gorge of Carp Creek (Kubsch; Crum); Carp Creek (Robinson & Crum); Fontinalis Run (Roberts). Emmet Co.: Big Stone Bay (Nichols); Pellston (Nichols); Carp L. (Ehlers). Mackinac Co.: Prentiss Bay (Ehlers).

Anomodon viticulosus (Hedw.) Hook. & Tayl. On limestone cliffs, also on tree trunks or the bases and exposed roots of trees, in moist, shady places. Emmet Co.: Levering (Robinson & Crum). Mackinac Co.: Mackinac I. (Kubsch; Shacklette).

Anomodon rostratus (Hedw.) Schimp. On rock (often limestone), soil, and bark at base of trees, sometimes on stumps, in rather moist, shady places. Cheboygan Co.: Colonial Pt., Burt L. (Nichols). Emmet Co.: Wilderness State Park (Shacklette; Pagán; Zwickey); Cecil Bay (Wynne). Mackinac Co.: Mackinac I. (Kubsch; Cobbe; Nichols); Prentiss Bay (Ehlers; Nichols).

Haplocladium microphyllum (Hedw.) Broth. [*Thuidium microphyllum* (Hedw.) Best] . On decayed wood, rock, soil, and occasionally bark of exposed roots or bases of trees, often in dry, brushy, disturbed places. Cheboygan Co.: Colonial Pt., Burt L. (Arzeni); Fontinalis Run (Roberts).

Thuidium abietinum (Hedw.) BSG. On rock and sandy, gravelly, or turfy soil in dry, usually calcareous habitats, frequently on old dunes or dry hillsides, in open, coniferous forests, on ledges or bases of cliffs, or among talus. Cheboygan Co.: Pine Pt., Douglas L. (Kubsch); Fairy I., Douglas L. (Nichols); Mill Creek (Wynne). Emmet Co.: Wilderness State Park (Pitelka; Pagán); Big Stone Creek (Robinson & Giesy); Big Stone Bay (Drew; Ehlers); Cecil Bay (Wynne; Zwickey;

Roberts; Sylva); Cross Village (Arzeni). Mackinac Co.: Mackinac I. (Tinney; Woollett; Grant; Kubsch); Bois Blanc I. (Benninghoff); Prentiss Bay (Ehlers).

Thuidium scitum (P.-Beauv.) Aust. On the bark of trees (often at the base), occasionally on rotten logs and stumps or soil in woods. Cheboygan Co.: Colonial Pt., Burt L. (Kubsch; Fulford; Wynne). Emmet Co.: Mt. Nebo, Wilderness State Park (Steere); Cecil Bay (Wynne); Cross Village (Steere); Carp L. (Nichols); Pellston (Nichols).

Thuidium minutulum (Hedw.) BSG. On decayed wood or on rocks and soil, often on the exposed roots or bases of trees in moist woods (possibly a calciphile). Cheboygan Co.: Black L. (Steere); Carp Creek (Steere); Reese's Bog (Sharp & Ireland); Burt L. (Steere).

Thuidium recognitum (Hedw.) Lindb. Very common and widespread in a broad range of habitats, on soil or humus and rocks, sometimes on logs, bases of trees, and exposed roots, in wet and dry woods, open swamps, or meadows. Cheboygan Co.: Colonial Pt., Burt L. (Ehlers); Fairy I., Douglas L. (Nichols); Carp Creek (Nichols); Iron Bridge (Frodin); Gorge of Carp Creek (Crum); Reese's Bog (Cobbe; Crum); Wolff's Bog (Fulford); Mud L. (Nichols). Emmet Co.: Wilderness State Park (Crum); Cecil Bay (Sharp; Wynne); Cross Village (Kubsch). Mackinac Co.: Prentiss Bay (Ehlers). Presque Isle Co.: Hammond Bay (Hatcher); Presque Isle lighthouse (Wetmore).

Thuidium delicatulum (Hedw.) BSG. Very common on soil or humus, decayed wood, and rocks, often on bark of exposed roots or tree bases, in moist or wet situations. Cheboygan Co.: Carp Creek (Cobbe); Gorge of Carp Creek (Tinney; Blagg; Pagán); Iron Bridge, Carp Creek (Ammons); Reese's Bog (Gleason; Blagg; Crum; Roberts; Wynne); Colonial Pt., Burt L. (Walp & Blagg). Mackinac Co.: Mackinac I. (Cobbe); Bois Blanc I. (Wynne; Benninghoff).

Thuidium philibertii Limpr. Rather uncommon but widely distributed, on soil or humus and logs in moist or wet woods. Emmet Co.: Levering (Ehlers). Mackinac Co.: Mackinac I. (Kauffman).

Helodium blandowii (Web. & Mohr) Warnst. On wet soil or humus in swamps, meadows, tamarack or *Thuja* bogs, often under shrubs at swampy margins of lakes and ponds. Cheboygan Co.: Douglas L. (Roberts); Reese's Bog (Crum; Pagán; Gleason); Gorge of Carp Creek (Kubsch; Wynne); Mud L. (Crum). Emmet Co.: Wilderness State Park (Wynne).

AMBLYSTEGIACEAE

Cratoneuron filicinum (Hedw.) Spruce. On wet soil (or sometimes on other substrata, such as rocks or logs) in seepage or overflow from springs or backwater of brooks (probably calciphilous). Cheboygan Co.: Carp Creek (Pagán); Iron Bridge, Carp Creek (Fulford); Gorge of Carp Creek (Roberts; Wynne); Reese's Bog (Nichols). Emmet Co.: Maple R. (Fulford; Kubsch); Wilderness State Park (Pagán); Mackinac Co.: Mackinac I. (Kubsch; Nichols; Steere); Bois Blanc I. (Wynne). Presque Isle Co.: Hammond Bay (Steere).

Campylium hispidulum (Brid.) Mitt. On soil or humus, decaying wood, bark of exposed roots or bases of trees and sometimes on rock, in moist, shady places. Cheboygan Co.: Carp Creek (Nichols); Burt L. (Crum); Colonial Pt., Burt L. (Kubsch; Arzeni). Emmet Co.: Wilderness State Park (Steere). Mackinac Co.: Mackinac I. (Nichols); Bois Blanc I. (Wynne); Pointe-aux-Pins, Bois Blanc I. (Steere). Presque Isle Co.: Hammond Bay (Steere); Ocqueoc Falls (Steere).

Campylium chrysophyllum (Brid.) J. Lange. On soil, humus, logs, bases of trees, and rocks, in moist, shady places. Cheboygan Co.: Douglas L. (Nichols); Fairy I., Douglas L. (Nichols); Reese's Bog (Fulford; Kubsch; Nichols); Lancaster L. (Nichols); Mud L. (Wynne). Emmet Co.: Maple R. (Fulford); Big Stone Creek (Steere); Big Stone Bay (Nichols); Cecil Bay (Zwickey); Mackinac Co.: Mackinac I. (Nichols). Presque Isle Co.: Presque Isle lighthouse (Wetmore); Ocqueoc Falls (Steere); Grand L. (Hermann).

Campylium polygamum (BSG) C. Jens. On soil in meadows, swamps, or wooded bogs. Cheboygan Co.: Douglas L. (Nichols); Burt L. (Nichols); Reese's Bog (Robinson & Crum). Emmet Co.: Cecil Bay (Frodin). Mackinac Co.: Bois Blanc I. (Wynne); L. Duncan, Bois Blanc I. (Steere).

Campylium stellatum (Hedw.) C. Jens. On wet, peaty or marly soil or sometimes sand, in swampy meadows, fens, or other wet places (in roadside ditches, near springs and waterfalls, etc.). Cheboygan Co.: Mill Creek (Wynne); Indian River (Wells). Emmet Co.: Wycamp L. (Gleason); Wilderness State Park (Pagán); Cecil Bay (Wynne; Roberts; Zwickey; Sharp); Waugoshance Pt. (Gates). Presque Isle Co.: Hammond Bay (Keck).

Leptodictyum brevipes (Card. & Thér. ex Holz.) Broth. Usually growing among grasses in partially shaded lawns, sometimes on bark at base of trees, concrete walls, etc. (rarely submerged). Cheboygan Co.: Polypody Bluff, Douglas L. (Nichols).

Leptodictyum trichopodium (Schultz) Warnst. In damp or swampy places, on soil, sometimes among grasses, on wet, rotten logs, or bark at base of trees. Cheboygan Co.: Douglas L. (Arzeni).—Var. *kochii* (BSG) Broth. On soil and various other substata in swampy places. Cheboygan Co.: Douglas L. (Nichols).

Leptodictyum riparium (Hedw.) Warnst. On wet soil, humus, old leaves, and rotten twigs and branches on the ground in swamps or swampy woods, sometimes submerged (at least at high water). Cheboygan Co.: Mill Creek (Wynne); Burt L. (Ehlers); Carp Creek (Ehlers); Gorge of Carp Creek, (Frodin).—Forma *longifolium* (Schultz) Grout. On swampy soil, submerged at least part of the year. Cheboygan Co.: Fontinalis Run (Roberts); Smith's Bog (Nichols & Ehlers); Black R. (Frodin). Emmet Co.: Levering (Roberts).

Hygroamblystegium tenax (Hedw.) Jenn. [*H. irriguum* (Wils.) Loeske]. On wet stones, soil, or other substrata (twigs, roots, logs, etc.) in or beside brooks and springs, often submerged. Cheboygan Co.: Burt L. (Nichols); Carp Creek (Ehlers; Nichols); Gorge of Carp Creek (Nichols; Nichols & Ehlers). Emmet Co.: Wycamp L. (Koch).—Var. *spinifolium* (Schimp) Jenn. [*H. irriguum* var. *spinifolium* (Schimp.) Grout]. On wet stones, soil, or other substrata in or beside streams. Cheboygan Co.: Nigger Creek (Morrison).

Amblystegium jurtzkanum Schimp. On decayed wood, soil, rock, and bark at base of trees in wooded swamps and other wet, shaded habitats. Cheboygan Co.: Douglas L. (Hermann). Emmet Co.: Cross Village (Kubsch).

Amblystegium serpens (Hedw.) BSG. On rotten wood, rocks, bark of exposed roots and bases of trees, and soil in wet, shaded habitats, especially swampy woods. Cheboygan Co.: Burt L. (Crum); Colonial Pt., Burt L. (Nichols); Reese's Bog (Feigley). Emmet Co.: Cross Village (Sharp); Ellis Twp. (Hatcher). Mackinac Co.: Mackinac I. (Nichols); Bois Blanc I. (Wynne).

Amblystegium varium (Hedw.) Lindb. On decayed wood, soil, rock and bark at base of trees in wet, shaded habitats. Cheboygan Co.: Gorge of Carp Creek (Kubsch); Black L. (Steere).

Drepanocladus uncinatus (Hedw.) Warnst. On rocks, logs, humus, and bark at base of trees in moist or dry, coniferous forests. Cheboygan Co.: Burt L. (Nichols & Ehlers); Reese's Bog (Crum; Roberts; Nichols); Carp Creek (Pagán); Gorge, Carp Creek (Crum); Iron Bridge, Carp Creek (Arzeni). Emmet Co.: Cecil Bay (Fulford). Mackinac Co.: Mackinac I. (Schneider; Nichols); Bois Blanc I. (Kubsch); Cut R. (Parmelee & Gilly).

Drepanocladus aduncus (Hedw.) Warnst. On soil in wet, often calcareous habitats (swamps, marshes, meadows, and boggy woods), frequently submerged or emergent (at least part of the year) in shallow water of pools, ditches, and springs. Cheboygan Co.: Burt L. (Wynne; Nichols & Ehlers; Nichols); Douglas L. (Nichols); Gorge of Carp Creek (Arzeni); Ingleside (Wynne); Bryant's Bog (Nichols); Smith's Bog (Nichols); schoolhouse on Biological Station-Cheboygan road (Wynne); Black L. (Wynne); Indian River (Wood; Wynne); S. of Mackinaw City (Robinson & Crum). Emmet Co.: Goose Pond, Wilderness State Park (Johns & Embree); Cecil Bay (Nichols); Trail's End, Cecil Bay (Wynne); Carp L. (Ehlers); Crooked R., S. of Alanson (Blum); Mackinac Co.: Mackinac I. (Wynne); Bois Blanc I. (Wynne). Presque Isle Co.: Grace Harbor (Gleason). A number of local collections qualify as the f. *capillifolius* (Warnst.) Mõnk., but intergradations make it impossible to segregate them satisfactorily.—Var. *polycarpus* (Bland. ex Voit) Roth. On wet soil in swamps, fens, meadows, swampy woods, etc. Cheboygan Co.: Burt L. (Nichols; Wynne); Sawmill Rd., Burt L. (Wynne); Reese's Bog (Wynne); Gorge of Carp Creek (Nichols; Ehlers); Linné's Bog (Wynne); Mud L. (Nichols; Ehlers; Wynne); Munro L. (Nichols; Wynne); Black L. (Wynne). Emmet Co.: Upper Maple R. (Robinson); Carp L. (Ehlers). Mackinac Co.: Bois Blanc I. (Kubsch; Wynne). Presque Isle Co.: Ocqueoc Falls (Wynne); Grace Harbor (Gleason).

Drepanocladus vernicosus (Lindb.) Warnst. On wet soil in fens. Cheboygan Co.: Douglas L. (Nichols); Reese's Bog (Bohlen). Emmet Co.: Big Stone Bay (Fulford); Cecil Bay (Fulford; Wynne; Roberts; Crum; Nichols; Sharp; Berkeley). Mackinac Co.: Mackinac I. (Steere; Hermann; Nichols). Presque Isle Co.: Ocqueoc L. (Crum).

Drepanocladus revolvens (Turn.) Warnst. On wet soil in swampy places, near springs, margins of lakes, etc., apparently most often in alkaline bogs. Cheboygan Co.: Little Lake Sixteen (Nichols). Emmet Co.: Cecil Bay (Robinson & Sharp); Big Stone Bay (Nichols). Mackinac Co.: Pointe-aux-Pins, Bois Blanc I. (Steere). —Var. *intermedius* (Lindb. ex Hartm.) Rich. & Wallace [*D. intermedius* (Lindb.) Warnst.]. On wet soil in swamps, meadows and fens. Cheboygan Co.: Reese's Bog (Wynne). Emmet Co.: Wilderness State Park (Pagán). Mackinac Co.: Bois Blanc I. (Wynne). Presque Isle Co.: Hammond Bay (Hatcher).

Drepanocladus exannulatus (BSG) Warnst. In wet places, sometimes submerged. Cheboygan Co.: Mud L. (Robinson).

Drepanocladus fluitans (Hedw.) Warnst. On wet soil in ditches, swamps, bogs, meadows, and swales or at margins of lakes and streams, often submerged in shallow pools. Cheboygan Co.: Gleason's Bog (Nichols & Ehlers); Mud L. (Wynne).

Hygrohypnum luridum (Hedw.) Jenn. [*H. palustre* (Hedw.) Loeske]. On wet rocks and sometimes logs in and beside streams, especially cascading brooks, or near falls (usually in places periodically inundated). Cheboygan Co.: Mill Creek (Wynne; Steere); S. of Burt L. (Nichols). Presque Isle Co.: Ocqueoc Falls (Steere).

Scorpidium scorpioides (Hedw.) Limpr. In shallow water and often submerged among sedges at the margins of pools in fens or swales, probably restricted to calcareous habitats. Cheboygan Co.: Blanchard's Bog (Kubsch); Mud L. (Frodin);

Black L. (Whitmire). Emmet Co.: Wilderness State Park (Pagán); Cecil Bay (Wynne; Zwickey). Mackinac Co.: W. of Pointe-aux-Pins, Bois Blanc I. (Steere). Presque Isle Co.: Hammond Bay (Wood; Keck; Hatcher).

Scorpidium turgescens (T. Jens.) Loeske [*Calliergon turgescens* (T. Jens.) Kindb.]. In very wet places in fens, often emergent from shallow water of temporary pools, probably restricted to calcareous habitats. Mackinac Co.: W. of Pointe-aux-Pins, Bois Blanc I. (Steere).

Calliergon cordifolium (Hedw.) Kindb. In or at margins of temporary pools and along streams, frequently in ditches or wet depressions, often emergent or sometimes submerged (at least temporarily), in swamps, swales, peat bogs, and wet woods, on soil, humus, and fallen twigs or branches. Cheboygan Co.: Reese's Bog (Frodin; Mazzer; Nichols). Carp Creek (Pagán); Mud L. (Wynne; Crum); Douglas L. (Ehlers); Burt L. (Nichols). Emmet Co.: Upper Maple R. (Fulford; Robinson); Wilderness State Park (Crum). Mackinac Co.: Mackinac I. (Harper). Presque Isle Co.: S. of Onaway State Park (Hubbard).

Calliergon richardsonii (Mitt.) Kindb. ex Warnst. On boggy soil in wet depressions or in shallow pools in swamps and spruce-white cedar bogs. Cheboygan Co.: Hebron Swamp (about 7 miles W. of Cheboygan) (Ireland).

Calliergon giganteum (Schimp.) Kindb. Emergent (or sometimes submerged) in shallow, usually temporary pools or ditches or at the edges of springs and brooks, in bogs, fens, and wooded swamps (apparently with tolerance for a wide range of pH). Cheboygan Co.: Douglas L. (Hermann); Burt L. (Nichols); S. of Mackinaw City (Robinson & Crum); Livingston's Bog (Kubsch); Gorge, Carp Creek (Robinson); Reese's Bog (Roberts). Emmet Co.: Carp L. (Ehlers); Wilderness State Park (Pagán); Cecil Bay (Wynne); Big Stone Bay (Nichols). Mackinac Co.: Bois Blanc I. (Wynne); Pointe-aux-Pins, Bois Blanc I. (Steere). Presque Isle Co.: Hammond Bay (Steere; Nichols); S. of Onaway State Park (Hubbard).

Calliergon stramineum (Brid.) Kindb. In shallow pools or damp depressions at the margin of *Sphagnum* bogs and in boggy woods. Cheboygan Co.: Mud L. (Nichols; Nichols & Ehlers; Gleason); Bryant's Bog (Nichols); Gleason's Bog (Nichols); Little Lake Sixteen (Nichols & Steere; Gleason).

Calliergon trifarium (Web. & Mohr) Kindb. Emergent from shallow water of stagnant pools or among sedges in fens (often around beach pools in the Great Lakes area), probably restricted to calcareous habitats. Emmet Co.: Cecil Bay (Wynne; Nichols; Zwickey; Steere; Roberts; Robinson & Crum). Mackinac Co.: E. of Pointe-aux-Pins, Bois Blanc I. (Steere). Presque Isle Co.: Hammond Bay (Steere).

Calliergonella cuspidata (Hedw.) Loeske. On wet humus in peat bogs, fens, swamps, meadows, and rarely wet woods. Cheboygan Co.: Mud L. (Robinson & Crum; Robinson; Sharp; Nichols); Burt L. (Nichols); Little Lake Sixteen (Nichols). Emmet Co.: Alanson (Nichols); Wilderness State Park (Frodin); Cecil Bay (Mazzer).

Pleurozium schreberi (Brid.) Mitt. [*Calliergonella schreberi* (Brid.) Grout]. Characteristically on the floor of rather dry forests, on humus and soil (or thinly covered rocks), sometimes on logs or stumps. Cheboygan Co.: Gorge of Carp Creek (Pagán); Iron Bridge, Carp Creek (Fulford); Bryant's Bog (Kubsch); Reese's Bog (Wynne); Mud L. (Crum). Emmet Co.: Cecil Bay (Wynne); Big Stone Bay (Ehlers); Stutsmanville (Robinson & Sharp); Maple River Twp. (Hatcher). Mackinac Co.: Bois Blanc I. (Wynne). Presque Isle Co.: Hammond Bay (Hatcher).

BRACHYTHECIACEAE

Tomenthypnum nitens (Hedw.) Loeske [*Camptothecium nitens* (Hedw.) Schimp.]. Very common in the North and characteristic of black spruce muskegs and fens, frequent in the Great Lakes area in swampy, calcareous habitats such as *Thuja* bogs, margins of brooks and edges of springs. Cheboygan Co.: Carp Creek (Pagán); Iron Bridge, Carp Creek (Fulford); Gorge of Carp Creek (Crum; Arzeni); Reese's Bog (Wynne; Feigley; Crum). Emmet Co.: Cecil Bay (Wynne; Roberts). Presque Isle Co.: Hammond Bay (Steere).

Brachythecium cyrtophyllum Kindb. [*Chamberlainia cyrtophylla* (Kindb.) Grout]. On bark of exposed roots and tree bases and on old logs in woods. Cheboygan Co.: Polypody Bluff, Douglas L. (Nichols).

Brachythecium populeum (Hedw.) BSG. On rocks and sometimes soil or humus in woods. Cheboygan Co.: Colonial Pt., Burt L. (Crum; Steere).

Brachythecium reflexum (Starke ex Web. & Mohr) BSG. On rocks and soil, logs and stumps, and bark of exposed roots and bases of trees in woods. Cheboygan Co.: Colonial Pt., Burt L. (Wynne; Kubsch; Lersten); Carp Creek (Robinson & Crum). Emmet Co.; Wycamp L. (Patterson); Pellston Hills (Sawyer); Maple River Twp. (Hatcher). Mackinac Co.: Mackinac I. (Nichols).

Brachythecium velutinum (Hedw.) BSG. On stones, soil, humus, logs and bark at base of trees in woods. Emmet Co.: Big Stone Creek (Robinson & Crum).

Brachythecium oxycladon (Brid.) Jaeg. & Sauerb. On soil, rocks, rotten wood, and bark of exposed roots or tree bases in shady places. Cheboygan Co.: Wolff's Bog (Fulford); Mud L. (Wynne). Emmet Co.: dam, Maple R. (Robinson & Crum). Mackinac Co.: Mackinac I. (Kubsch).—Forma *falcatum* Grout. On log, base of tree, and sandy soil. Cheboygan Co.: Douglas L. (Nichols). Emmet Co.: Cecil Bay (Nichols). Presque Isle Co.: Hammond Bay (Steere). The plants are rather small, with falcate-secund, plicate leaves. Unlike *B. oxycladon*, they are autoicous, and I suspect that they are better referred to the *B. salebrosum*, which is, of course, very poorly understood in its extreme variability.

Brachythecium salebrosum (Web. & Mohr) BSG. On earth, stones, exposed roots and bases of trees, and logs in shady, often rather dry and disturbed places. Cheboygan Co.: Maple R. (Pagán); Reese's Bog (Nichols); Grapevine Pt., Douglas L. (Nichols); Colonial Pt., Burt L. (Kubsch); Ellis Twp. (Hatcher). Emmet Co.: Carp L. (Ehlers); Big Stone Bay (Nichols & Ehlers); Cecil Bay (Fulford); Good Hart (Kubsch).

Brachythecium turgidum (Hartm) Kindb. On wet soil near streams and pools, on boulders near waterfalls, and on wet cliffs. Mackinac Co.: W. of Pointe-aux-Pins, Bois Blanc I. (Steere).

Brachythecium rutabulum (Hedw.) BSG. On soil, rocks, logs, and bark at base of trees in moist, shady places. Cheboygan Co.: Burt L. (Nichols); Wolff's Bog (Fulford); Reese's Bog (Ireland; Nichols); Smith's Bog (Nichols); Gorge of Carp Creek (Kubsch). Emmet Co.: Cecil Bay (Wynne). Mackinac Co.: Mackinac I. (Nichols; Kubsch); Bois Blanc I. (Benninghoff). Presque Isle Co.: Presque Isle lighthouse (Wetmore).

Brachythecium rivulare BSG. On wet rocks or soil in shady places, inundated periodically but not submerged, usually in seepage, often in or along brooks. Cheboygan Co.: Burt L. (Ehlers); Mill Creek (Wynne; Robinson & Crum; Arzeni; Steere); Carp Creek (Wynne); Gorge of Carp Creek (Wynne; Kubsch).

Brachythecium plumosum (Hedw.) BSG [*B. flagellare* (Hedw.) Jenn.]. On moist rocks, generally in or near streams in woods. Cheboygan Co.: Gorge of Carp Creek (Arzeni).

Bryhnia novae-angliae (Sull. & Lesq. ex Sull.) Grout. On moist, shaded rocks, soil, or sometimes humus. Cheboygan Co.: Mill Creek (Crum); Reese's Bog (Wynne); N. Fishtail Bay, Douglas L. (Nichols); Burt L. (Nichols).

Bryhnia graminicolor (Brid.) Grout. On moist, shaded rocks, sometimes on soil. Cheboygan Co.: Fairy I., Douglas L. (Nichols).

Eurhynchium pulchellum (Hedw.) Jenn. [*E. strigosum* (Web. & Mohr) BSG]. On soil or humus of mounds or banks in woods or on decayed logs, stumps, fallen twigs, or leaf litter, sometimes on bark at the base of trees or on rocks. Cheboygan Co.: Fairy I., Douglas L. (Nichols); Colonial Pt., Burt L. (Schneider); Ellis Twp. (Hatcher); Wolff's Bog (Fulford); Reese's Bog (Wynne); Gorge of Carp Creek (Feigley; Pagán); Mud L. (Frodin); Mill Creek (Wynne). Emmet Co.: Good Hart (Kubsch); Wilderness State Park (Wagoner; Pagán); Cecil Bay (Crum); Big Stone Bay (Nichols & Ehlers). Mackinac Co.: Bois Blanc I. (Wynne; Benninghoff). Nichols collected a poor specimen of what appears to be the var. *diversifolium* (Schleich. ex BSG) C. Jens. on Fairy Island, Douglas Lake. The variety seems to me no more than a response to poor growth conditions.

Eurhynchium riparioides (Hedw.) Rich. [*E. rusciforme* (Brid.) Milde]. On wet rocks in or near brooks, often submerged in swiftly moving water or continually splashed by waterfalls, probably preferring calcareous habitats. Cheboygan Co.: Mill Creek (Wynne; Robinson & Crum).

Cirriphyllum piliferum (Hedw.) Grout. On soil, humus, or tree bases in moist, shady places, particularly on steep, wet banks near springs or brooks. Cheboygan Co.: Gorge of Carp Creek (Crum; Wynne).

Rhynchostegium serrulatum (Hedw.) Jaeg. & Sauerb. [*Eurhynchium serrulatum* (Hedw.) Kindb.]. On soil and humus, rotten wood, and bases of trees in woods. Cheboygan Co.: Colonial Pt., Burt L. (Kubsch; Wynne).

Rhynchostegiella compacta (C.M.) Loeske [*Amblystegium compactum* (C.M.) Aust.]. On moist, shaded rocks, frequently on limestone cliffs, also on decayed logs and stumps and bark of exposed roots and bases of trees and soil or humus in swampy or boggy woods. Cheboygan Co.: Iron Bridge, Carp Creek (Bowen); Reese's Bog (Sharp); Colonial Pt., Burt L. (Nichols). Mackinac Co.: W. of Pointe-aux-Pins, Bois Blanc I. (Steere).

ENTODONTACEAE

Entodon cladorrhizans (Hedw.) C.M. On rotten wood, leaf litter, bases of trees, and sometimes rock or soil in woods. Cheboygan Co.: Colonial Pt., Burt L. (Nichols; Wynne); Black R. (Steere); Trout Creek (Steere). Emmet Co.: Harbor Springs (Steere); Cecil Bay (Wynne).

Entodon seductrix (Hedw.) C.M. On rotten logs and various other substrata (exposed roots and bases of trees, soil, stones, etc.), often in rather dry, shady places. Cheboygan Co.: Black L. (Banwell).

PLAGIOTHECIACEAE

Plagiothecium denticulatum (Hedw.) BSG. On soil and humus, particularly on steep, wooded banks, often on bark of exposed roots and bases of trees, rotten wood and rocks. Cheboygan Co.: Colonial Pt., Burt L. (Crum); Iron Bridge, Carp Creek (Fulford); Mud L. (Gleason). Emmet Co.: Carp L. (Ehlers); Stutsmanville (Robinson & Sharp). Mackinac Co.: Bois Blanc I. (Kubsch).—Var. *tenellum* BSG. On shaded rock, frequently on the surface or in crevices of cliffs, also on logs, stumps, bark at base of trees, and humus. Cheboygan Co.: Reese's Bog (Crum). Emmet Co.: Cross Village (Sharp).

Plagiothecium sylvaticum (Brid.) BSG. On soil and humus, rocks, decayed wood, and bark at base of trees in woods. Cheboygan Co.: Mud L. (Roberts); Mullett L. (Sharp). Emmet Co.: Cross Village (Thomas); Maple River Twp. (Hatcher).—Var. *roeseanum* (BSG) Lindb. [*P. roeseanum* BSG] . Usually in crevices or on ledges of cliffs, sometimes on soil of shaded banks. Cheboygan Co.: NW. shore of Burt L. (Robinson & Crum); Fairy I., Douglas L. (Nichols). Emmet Co.: dam, Maple R. (Robinson & Crum).

SEMATOPHYLLACEAE

Heterophyllium haldanianum (Grev.) Kindb. Usually on dry logs or stumps, often in partial shade (at the edges of woods or in brushy thickets, for example), also occasionally on rock, soil, or humus, and bark at base of trees. Cheboygan Co.: Reese's Bog (Crum; Feigley; Roberts); Colonial Pt., Burt L. (Fulford); Wolff's Bog (Fulford); Iron Bridge, Carp Creek (Frodin); Gorge of Carp Creek (Wynne; Crum; Pagán); Mud L. (Pagán). Emmet Co.: Levering (Ehlers); Upper Maple R. (Robinson); Maple River Twp. (Hatcher); Big Stone Bay (Nichols). Mackinac Co.: Bois Blanc I. (Benninghoff); Prentiss Bay (Ehlers); Cut R. (Parmelee & Gilly).

Brotherella recurvans (Mx.) Fl. On rotten logs and stumps, humus, bark of exposed roots and tree bases, and sometimes on thin humus over boulders in moist woods. Cheboygan Co.: Burt L. (Nichols); Bryant's Bog (Nichols); Reese's Bog (Wynne; Pagán; Kubsch; Crum; Nichols); Mud L. (Crum; Pagán); Gorge of Carp Creek (Roberts). Emmet Co.: Good Hart (Kubsch); Wycamp L. (Gleason); Stutsmanville (Robinson & Sharp). Mackinac Co.: Bois Blanc I. (Kubsch); Cut River (Parmelee & Gilly).

HYPNACEAE

Platydictya jungermannioides (Brid.) Crum[2] [*Amblystegiella sprucei* (Bruch) Loeske] . On soil and rock, especially in shaded crevices of cliffs, but also in other moist, shaded habitats (on logs, bases of trees, and soil of banks or upturned roots). Cheboygan Co.: Reese's Bog (Fulford; Robinson). Emmet Co.: Wilderness State Park (Arzeni; Wagoner; Patterson). Mackinac Co.: Mackinac I. (Nichols; Steere).

Platydictya subtile (Hedw.) Crum[2] [*Amblystegiella subtilis* (Hedw.) Loeske]. On bark at base of trees. Cheboygan Co.: Colonial Pt., Burt L. (Crum); mouth of Carp Creek, Burt L. (Robinson & Crum); George, Carp Creek (Nichols); Fairy I., Douglas L. (Nichols); Mud Lake (Nichols & Ehlers). Emmet Co.: Big Stone Bay (Nichols). Mackinac Co.: Prentiss Bay (Ehlers).

Platygyrium repens (Brid.) BSG. On logs and stumps or on trunks and bases of trees, rarely on rocks, typically in rather dry, open woods. Cheboygan Co.: Gorge of Carp Creek (Crum; Nichols); Reese's Bog (Feighley; Kubsch); Pine Pt., Douglas L. (Kubsch). Emmet Co.: Good Hart (Kubsch); Wilderness State Park (Pagán).

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[2] Because *Amblystegiella* Loeske (1903) was antedated by *Platydictya* Berk. (1863), the following name changes are necessary: *Platydictya confervoides* (Brid.) n. comb. (*Hypnum confervoides*, Brid., Musc. Recent. Suppl. 2:153. 1812). *Platydictya jungermannioides* (Brid.) n. comb. (*Hypnum jungermannioides* Brid., Musc. Recent. Suppl. 2:255. 1812). *Platydictya jungermannioides* var. *minutissima* (Sull. & Lesq.) n. comb. (*Hypnum minutissimum* Sull. & Lesq., Musci Bor.-Amer. (ed.1) 343. 1856). *Platydictya subtile* (Hedw.) n. comb. (*Leskea subtilis* Hedw., Sp. Musc. 221. 1801).

Pylaisia polyantha (Hedw.) BSG. On the bark of trees. Cheboygan Co.: Reese's Bog (Nichols); Iron Bridge, Carp Creek (Frodin); Gorge of Carp Creek (Arzeni). Emmet Co.: Cecil Bay (Wynne; Bevis); Big Stone Bay (Nichols). Mackinac Co.: Mackinac I. (Hermann); Bois Blanc I. (Wynne). Presque Isle Co.: Presque Isle lighthouse (Wetmore).

Pylaisia selwynii Kindb. On the bark of trees. Cheboygan Co.: Douglas L. (Ehlers); Reese's Bog (Pagán); Smith's Bog (Nichols); Gorge of Carp Creek (Crum); Colonial Pt., Burt L. (Wynne; Ehlers). Emmet Co.: Wilderness State Park (Fulford).

Homomallium adnatum (Hedw.) Broth. On rocks and bases of trees or sometimes stumps in woods. Cheboygan Co.: Pine Pt., Douglas L. (Clark).

Hypnum imponens Hedw. Typically on rotten logs, often on rocks, and occasionally on humus or bark at base of trees. Cheboygan Co.: Mud L. (Wynne); Gorge of Carp Creek (Wynne; Nichols & Ehlers); Reese's Bog (Crum; Pagán).

Hypnum fertile Sendt. Uusually on rotten logs, but also on soil, rocks, and bases of trees. Cheboygan Co.: Colonial Pt., Burt L. (Nichols).

Hypnum lindbergii Mitt. [*H. patientiae* Lindb.]. On wet soil in swampy places, often near water, sometimes on wet logs or rocks. Cheboygan Co.: Burt L. (Crum); Reese's Bog (Wynne; Nichols; Iwatsuki); Gorge of Carp Creek (Arzeni); Carp Creek (Cobbe; Pagán); Levering-Cheboygan Rd. (Robinson); Pine Pt., Douglas L. (Kubsch); N. Fishtail Bay, Douglas L. (Nichols); Smith's Bog (Nichols); Mill Creek (Robinson & Crum). Emmet Co.: Levering (Ehlers); Big Stone Bay (Nichols); Cecil Bay (Roberts; Crum); Wilderness State Park (Pagán). Mackinac Co.: Bois Blanc I. (Wynne; Cobbe); Pointe-aux-Pins, Bois Blanc I. (Steere); Mackinac I. (Hermann). Presque Isle Co.: Hammond Bay, (Steere). Some of the local collections could be referred (with little profit) to *H. pratense* Koch.

Hypnum cupressiforme Hedw. On calcareous rock and soil, often in dry, exposed places. Mackinac Co.: Mackinac I. (Nichols).

Hypnum reptile Mx. On exposed roots or bases of trees, rotten logs and stumps, and rocks in woods. Cheboygan Co.: Mud L. (Crum); Douglas L. (Crum); Colonial Pt., Burt L. (Crum; Ehlers); Reese's Bog (Fulford; Wynne; Nichols). Emmet Co.: Wilderness State Park (Pagán); Cecil Bay (Wynne). Mackinac Co.: Bois Blanc I. (Wynne). Presque Isle Co.: Presque Isle lighthouse (Wetmore).

Isopterygium turfaceum (Lindb.) Lindb. [*Plagiothecium turfaceum* (Lindb.) Lindb.]. On decaying wood, humus, and bases of trees in moist woods. Cheboygan Co.: Burt L. (Nichols); Reese's Bog (Blagg; Nichols; Crum; Wynne; Lawton); Iron Bridge, Carp Creek (Ropes); Gorge of Carp Creek (Wynne; Crum); Mud L. (Ehlers). Emmet Co.: Wycamp Creek (Gleason). Mackinac Co.: Bois Blanc I. (Kubsch; Benninghoff); Deer L., Bois Blanc I. (Shetler).

Isopterygium pulchellum (Hedw.) Jaeg. & Sauerb. [*Plagiothecium pulchellum* (Hedw.) BSG]. On decayed wood, rock, soil, or humus in moist, deeply shaded places, such as the undersides of logs, upturned roots of fallen trees, crevices of cliffs, or the entrance to animal burrows. Cheboygan Co.: Hermit's Bog (Ireland).

Taxiphyllum deplanatum (Schimp. ex Sull.) Fl. [*Plagiothecium deplanatum* (Sull.) Grout]. On soil and rock, decayed wood and humus, and sometimes bark at base of trees. Mackinac Co.: Mackinac I. (Steere).

Ctenidium molluscum (Hedw.) Mitt. [*Hypnum molluscum* Hedw.]. On moist shaded soil, humus, and rocks. Cheboygan Co.: Iron Bridge, Carp Creek

(Arzeni). Emmet Co.: E. of Schoolhouse, T36, R4W, S12 (Schnooberger).

Ptilium crista-castrensis (Hedw.) De Not.[*Hypnum crista-castrensis* Hedw.]. On humus and old, mossy logs in moist forests. Cheboygan Co.: Reese's Bog (Crum; Wynne; Roberts; Fulford); Gorge of Carp Creek (Pagán). Emmet Co.: Maple R. (Fulford); Cecil Bay (Wynne); Big Stone Bay (Gambill); Stutsmanville (Robinson & Sharp). Mackinac Co.: Bois Blanc I. (Wynne).

HYLOCOMIACEAE

Rhytidiadelphus triquetrus (Hedw.) Warnst. On humus or sometimes logs and stumps in rather dry to moist forests. Cheboygan Co.: Reese's Bog (Wynne; Roberts; Nichols & Ehlers); Carp Creek (Pagán): Iron Bridge, Carp Creek (Frodin); Gorge of Carp Creek (Crum; Nichols & Ehlers). Emmet Co.: Upper Maple R. (Robinson); Cecil Bay (Wynne; Nichols & Ehlers); Big Stone Bay (Nichols). Mackinac Co.: Mackinac I. (Kubsch); Bois Blanc I. (Wynne); Pointe-aux-Pins, Bois Blanc I. (Steere); Prentiss Bay (Ehlers). Presque Isle Co.: Hammond Bay (Hatcher).

Rhytidiadelphus squarrosus (Hedw.) Warnst. On soil, humus, logs, or rocks in wet, shady places. Cheboygan Co.: Douglas L. (Hermann); Reese's Bog (Pagán).

Hylocomium splendens (Hedw.) BSG. On humus, soil, and rocks in moist forests, especially in deeply shaded ravines, occasionally also on rotten wood or bark at base of trees. Cheboygan Co.: Reese's Bog (Crum; Wynne; Roberts; Fulford). Emmet Co.: Wilderness State Park (Pagán); Cecil Bay (Wynne). Presque Isle Co.: Hammond Bay (Hatcher); Presque Isle lighthouse (Wetmore).

BUXBAUMIACEAE

Buxbaumia aphylla Hedw. A pioneer of disturbed sandy or clayey banks and sometimes also on logs or stumps, usually in partial shade, in moist forests and also open, dry woods (such as oak-poplar or jack pine stands), frequently growing on banks of trails and roadbanks, often associated with white flecks of immature *Cladonia*. Cheboygan Co.: Beaver Dam Hill, Carp Creek (Steere); Biological Station campus (Steere); Gorge of Carp Creek (Crum; Wynne; Pagán; Nichols); Iron Bridge, Carp Creek (Steere); above Gorge (Giesey; Crum); Grapevine Pt., Douglas L. (Crum; Kubsch); Hogback Rd.(Fulford); Colonial Pt., Burt L. (Steere); Mud L. (Beach; Robinson & Sharp); Little Lake Sixteen (Steere). Emmet Co.: Mt. Nebo trail, Wilderness State Park (Phillips); Cecil Bay (Steere); Pellston Hills (Lowy). Mackinac Co.: Bois Blanc I. (Wynne); Pointe-aux-Pins, Bois Blanc I. (Steere).

DIPHYSCIACEAE

Diphyscium foliosum (Hedw.) Mohr. On soil of moist, shaded banks in the late stages of moss-lichen succession, sometimes on moist rock walls of stream gorges. Cheboygan Co.: Colonial Pt., Burt L. (Feigley; Sharp; Wynne); Munro Twp. (Schneider). Emmet Co.: Cross Village (Lange). Mackinac Co.: Mackinac I. (Harper; Kauffman).

TETRAPHIDACEAE

Tetraphis pellucida Hedw. Very common on damp, very rotten stumps and logs in moist forests, sometimes on wood humus, rarely on soil or rock. Cheboygan Co.: Wolff's Bog (Fulford); Reese's Bog (Crum; Wynne; Roberts); Gorge of Carp Creek (Pagán); Iron Bridge, Carp Creek (Fulford); Mud L. (Hatcher; Wynne). Emmet Co.: Wycamp L. (Koch); Stutsmanville (Robinson & Sharp); Cecil Bay (Wynne). Mackinac Co.: Cut R. (Parmelee & Gilly); Bois Blanc I. (Kubsch).

POLYTRICHACEAE

Atrichum angustatum (Brid.) BSG. On light, often sandy soil in dry, open woods and frequently in disturbed places (poor lawns, roadbanks, bare mounds in woods). Cheboygan Co.: Gorge of Carp Creek (Pagán); Colonial Pt., Burt L. (Kubsch; Ehlers); Mud L. (Wynne); Grapevine Pt., Douglas L. (Nichols). Emmet Co.: Maple River Twp. (Hatcher). Mackinac Co.: Mackinac I. (Kubsch).

Atrichum undulatum (Hedw.) P.-Beauv. On rich, humic soil in moist woods and shady ravines and on clay or mud, especially along streams. Cheboygan Co.: Mud L. (Nichols); E. of Burt L. (Nichols).

Polytrichum formosum Hedw. On soil or rocks in damp, shady woods. Emmet Co.: Pellston Hardwoods (Nichols).—Var. *aurantiacum* (Hoppe ex Funck) Hartm. [*P. gracile* Turn.]. On soil or humus in bogs, damp or boggy woods, sedge meadows, etc. Cheboygan Co.: Grapevine Pt., Douglas L. (Embree & Dieterle); Little Lake Sixteen (Koch).

Polytrichum ohioense Ren. & Card. On soil or humus in woods. Cheboygan Co.: Colonial Pt., Burt L. (Kubsch; Wynne; Nichols). Emmet Co.: Carp L. (Ehlers).

Polytrichum commune Hedw. On soil (often sandy) in moist or wet woods, common near lakes, ponds, or streams. Cheboygan Co.: Bryant's Bog (Cobbe); Nichols' Bog (Kubsch); Mud L. (Gleason). Emmet Co.: Stutsmanville (Sharp).

Polytrichum juniperinum Hedw. On soil and rocks usually in dry, exposed or partially shaded places, frequent on bare roadbanks, in dry, open woods or on sunny knolls in moist woods, dry heaths, pastures, etc. Cheboygan Co.: Grapevine Pt., Douglas L. (Crum; Nichols); Mud L. (Wynne); Long L. (Fulford). Emmet Co.: Cross Village (Arzeni); Maple River Twp. (Hatcher). Mackinac Co.: Bois Blanc I. (Wynne).—Var. *alpestre* (Hoppe) BSG. Forming dense clumps or hummocks (usually with *Sphagnum*) in bogs, damp heaths, or boggy woods. Cheboygan Co.: Mud L. (Crum; Wells); Bryant's Bog (Roberts); Little Lake Sixteen (Crum). Emmet Co.: Stutsmanville (Robinson & Sharp); Maple River Twp. (Hatcher); Cecil Bay (Wynne). Presque Isle Co.: Hammond Bay (Hatcher).

Polytrichum piliferum Hedw. On dry, often sandy or gravelly soil, usually in the open, commonly on thin soil over rocks, bare soil of roadbanks, sunny knolls or trail banks in forests, and often in dryish heaths or old fields. Cheboygan Co.: Pine Pt., Douglas L. (Crum); Mud L. (Hatcher; Wells); Smith's Bog (Wynne); Emmet Co.: Stutsmanville (Robinson & Sharp). Mackinac Co.: Bois Blanc I. (Wynne).

Michigan State University Herbarium

The Michigan State University Herbarium has been moved recently to a newly renovated building in which it has exclusive occupancy. Dedication and open house will be held in the spring of 1964. A grant from the National Science Foundation matched by University funds has provided substantial improvements in research and storage facilities. Dr. William B. Drew, Chairman of the Department of Botany and Plant Pathology, is Director of the Herbarium, which is subdivided into two units: the Beal-Darlington Herbarium of vascular plants with Dr. John H. Beaman as Curator and the Cryptogamic Herbarium of which Dr. Henry A. Imshaug is Curator. Seven faculty Herbarium Associates have been designated as follows: Dr. John W. Andresen, Gymnosperms; Dr. John E. Cantlon, Ecology; Dr. Aureal T. Cross, Paleobotany; Dr. H. T. Darlington, Bryophytes; Dr. Mladen Kabalin, Library; Dr. I. W. Knobloch, Pteridophytes; and Dr. G. W. Prescott, Algae.

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(On the cover: The Michigan Lily, Lilium michiganense, *photographed in July, 1961, in Genesee County, Michigan, by Edward M. Brigham, III. See page 44.)*

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Articles and notes relating to any phase of botany in the Upper Great Lakes region are welcomed; manuscripts should be sent to the editor in chief. Subscriptions and inquiries regarding them (from those not members of the Michigan Botanical Club) should be sent to the circulation manager, who will assume that subscriptions received prior to the last number of a volume are intended to begin with the first number of that volume unless specified to the contrary.

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THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora and to establish suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Inquiries regarding membership may be directed to the state secretary or, from those residing where there is a chapter, to the appropriate chapter secretary. (The Southeastern Chapter is centered in the Detroit metropolitan area; the Huron Valley Chapter, in Washtenaw County; and the Northwestern Chapter, in the northwestern Lower Peninsula.) Dues are modest, but vary slightly among the chapters; in all cases, they include subscription to THE MICHIGAN BOTANIST.

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A HYBRID TWAYBLADE AND ITS RARER PARENT, *LISTERA AURICULATA*, IN NORTHERN MICHIGAN

Fred W. Case, Jr.
Cranbrook Institute of Science, Bloomfield Hills,
and Arthur Hill High School, Saginaw

So far as I have been able to determine, there are no previous records of hybrids in the genus of true twayblades, *Listera*. The discovery of rather clear-cut natural hybrid twayblades in the Upper Peninsula of Michigan, therefore, holds considerable botanical interest. The purpose of these notes is to report the details of the discovery and known distribution of the hybrids, to present new records of the occurrence of its rarer parent, *L. auriculata,* in two counties of northern Michigan, and to describe and name the new hybrid.

Since twayblade orchids are quite inconspicuous and rather rare, a brief account of all Michigan species may prove useful.

Three species of *Listera,* the true twayblades, occur in Michigan: *L. cordata* (L.) R. Br., the heart-leaved twayblade; *L. convallarioides* (Sw.) Nutt., the broad-leaved twayblade; and *L. auriculata* Wiegand, the auricled twayblade. All boreal in distribution, they are virtually absent from the southern counties of the state. The heart-leaved twayblade comes closest to possessing a general distribution in Michigan, and probably occurs locally in most extensive, cold sphagnum bogs from the north-central Lower Peninsula northward. It occurs across the continent and across Europe, as well. *L. convallarioides,* rare and local in lower Michigan, becomes increasingly common northward. In the Lower Peninsula, it frequents springy "seeps" at the base of north-facing slopes, stream-banks under cedars (*Thuja*) and occasionally the "wells" and pockets around the roots of cedars in the margins of heavily wooded cedar-balsam (*Abies*) bogs. It seldom grows in sphagnum. Less selective in the Upper Peninsula, it becomes common in damp coniferous interdunal thickets and forests along the Michigan shores of Lake Superior. Here, it occasionally becomes the most abundant forest herb, spreading in great colonies across large areas. Damp mucky or sandy areas subject to washing in heavy rain favor it. The broad-leaved twayblade is transcontinental in the north.

Listera auriculata has always been considered the rarest species of the genus in Michigan, and was long reported only from Isle Royale. Dr. E. G. Voss discovered it in Schoolcraft County in 1954. Shortly thereafter, the auricled twayblade was discovered on Sugar Island in the St. Mary's River by Jarl Hiltunen. Until now, these were the only Michigan records other than Isle Royale. In addition, there is an 1865 collection in the University of Michigan Herbarium, made at Sault Ste. Marie [Chippewa County] by T. C. Porter. This is a mixed collection, including some *L. convallarioides,* which is the name on the original label and the name under which it was reported (Pap. Mich. Acad. 1: 156. 1923). The species occurs in a rather narrow band from the northwestern shores of Lake Superior eastward to northern New England and maritime Canada.

In July, 1962, H. S. Veltman, G. L. Burrows, IV, my wife, and I visited Grand Marais, in Alger County, Michigan, to try to track down new stations for *L. auriculata*. Several days of intensive search in the vicinity of Grand Marais produced over 22 species of orchids, but at first no auricled twayblade. Our first hint of success occurred when Mr. Veltman found a small, obviously clonal colony of a rather large twayblade which appeared to be exactly intermediate between *L. convallarioides* and the *L. auriculata* we sought. The plants grew in company with thousands of plants of *L. convallarioides* in sand under alders, in the ravine below Sable Falls. An exhaustive search of the valley produced no other intermediate plants, nor did it produce clear-cut *L. auriculata*. To help establish that our strange plants were of hybrid origin, we would have to find the auricled twayblade growing in the region, for the only known mainland station was in Schoolcraft County and at least 30 miles away.

Finding nothing further of interest at Sable Falls, we decided to strike out into new territory. Knowing that *L. auriculata* usually grows under alders in damp, rather raw sands, especially along rivers, we decided to look along the Sucker River about 7 miles east of Grand Marais. Here, my wife found a sterile plant of a listera growing in sandy wash along the creek. The dark bluish-green color, the leaf texture and its shape almost certainly meant auricled twayblade, but so inconspicuous is the plant among the sedges and under the twisted trunks of the alders (*Alnus*), that it took us an hour to find a flowering specimen. Finally, though, a dozen flowering plants were discovered; all proved to be typical *L. auriculata*. So— about 8 miles from what we were certain was a hybrid twayblade, we located the missing parent species, and established a new county record for it, too! With the now positive proof of *L. auriculata* in the vicinity, there could be little doubt of the hybrid nature of our Sable Falls plants, but we still hoped to find this parent closer to our station.

As we triumphantly approahced Grand Marais and supper, we passed a tiny picnic area, Kahle Park, at the edge of town. The cover along the harbor shore at this point was mainly alders growing on sandy wash. A joking challenge to search for the auricled twayblades here was equally lightly accepted—supper would have to wait. Before the last person had left the car, the first had found auricled twayblades! Here, we were only a scant mile and a half from the putative hybrids. Subsequent search revealed that in the area immediately east of the town, both *L. convallarioides* and plants of varying degrees of intermediacy occur with frequency. *L. auriculata*, far less tolerant of habitat variations, grows here only in a limited zone of sandy muck or raw sand along the harbor shore.

Our return home from Grand Marais took us along the Lake Superior shore into Luce County, and thence back onto paved roads south of Deer Park. Just inside Luce County, along the Dead Sucker River--Blind Sucker River flood area, in a vast area of very scrubby alder and old beaver workings, we stopped to search again for listeras. Almost immediately we found *L. auriculata,* yet another new county record. But even more interesting, growing with the auricled twayblades were scattered plants of our hybrid. At this station *Listera convallarioides* was not present although it grew at points not far away. These hybrids were identical with those at Sable Falls. About their being hybrids, there can be little doubt; they differ from any known twayblade, and they are intermediate

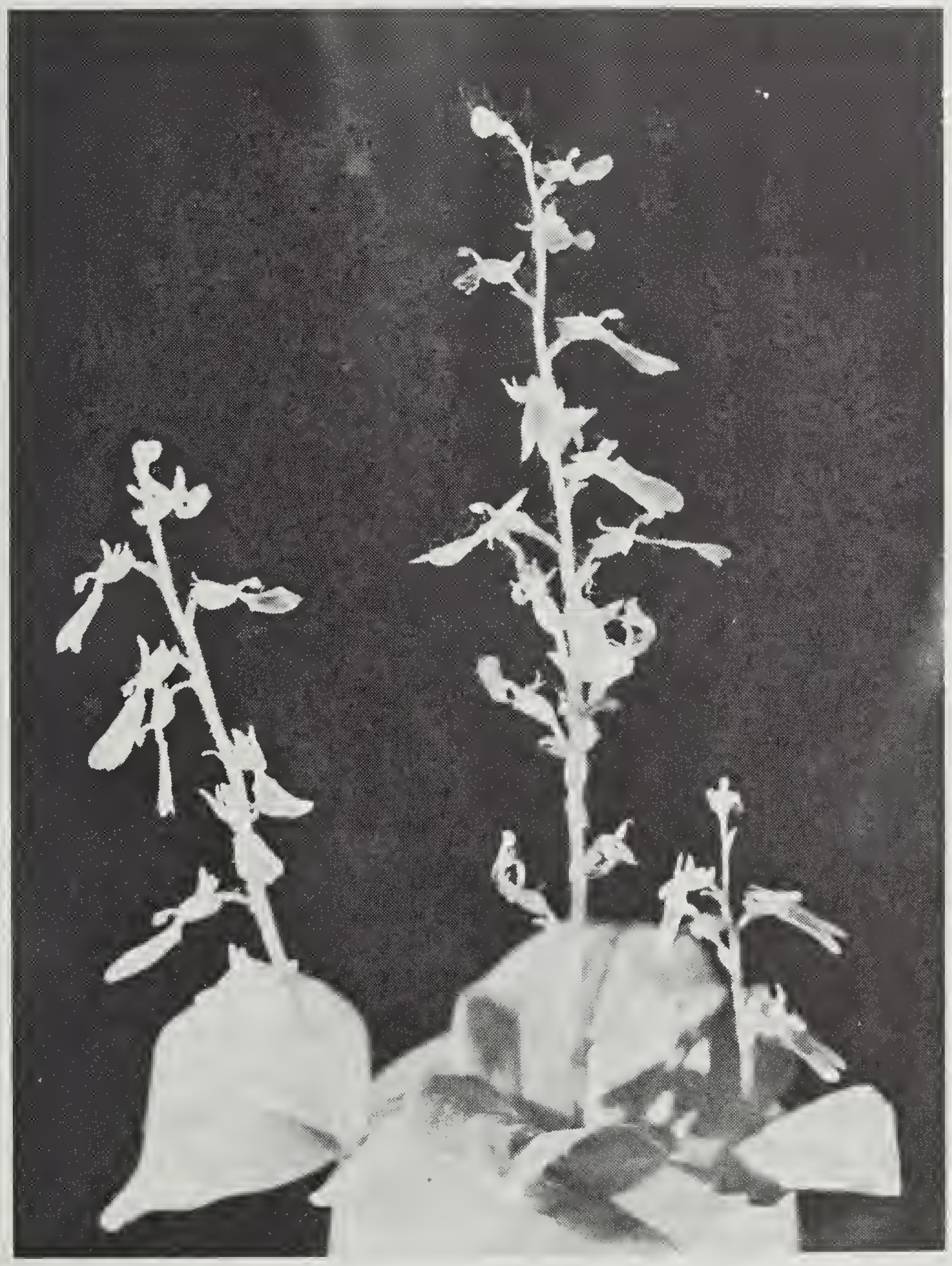

Fig. 1. *Listera convallarioides, L. × veltmanii,* and *L. auriculata* (left to right), collected at Grand Marais, Michigan, July 3, 1962. (Size differences of these particular specimens are not significant.)

between the putative parents in nearly every feature of structure and aspect of growth habit.

This is the first instance, as far as I am aware, of a report of natural hybrids in the genus *Listera*. D. S. Correll, in his *Native Orchids of North America* (1950) does not mention any. It is appropriate, therefore, not only to call attention to the occurrence of hybrids in this genus, but, in keeping with the custom of nomenclature of hybrids in other orchid groups, to give the hybrid a name. I take great pleasure in naming this listera hybrid for Herbert S. Veltman, discoverer of the first colony of these plants in the field.

LISTERA X VELTMANII F. W. Case, hybr. nov. naturalia inter parentes L. auriculatam et L. convallarioidem; folia ovata usque ad suborbicularia, 2-5.2 cm. longa, 1.7-3.4 cm. lata, coeruleo-viridia. Racemus laxus, rhachide glanduloso-pubescenti. Flores 4-18, luteo-virides, translucentes. Pedicelli et ovarii costae glanduloso-pubescentes. Labellum breve unguiculatum, cuneatum, auriculis parvis supra ungulam instructum.

Listera × *veltmanii*, a natural hybrid between the parents *L. auriculata* and *L. convallarioides* (see Figs. 1 & 2).

Leaves ovate-elliptic to suborbicular, 2-5.2 cm long, 1.7-3.4 cm wide, dark bluish green as in *L. auriculata*, carried slightly above the horizontal, not strongly recurving beyond the middle. Raceme laxly 4-18-flowered, 1.7-3.5 cm in diameter, rachis glandular-pubescent.. Floral bracts 2-3.5 mm long, 2 mm wide, sheathing the pedicel, ovate to oblong, subacute, becoming hyaline at the apex, except along the veins. Pedicels sparsely glandular-pubescent, with occasional sparse pubescence along the ribs of the pedicellate ovary. Pedicel and ovary together 7-9 mm long. Flower segments yellowish-whitish green, translucent. Sepals and petals similar, strongly reflexed, 4-6 mm long, 1 mm or less wide, sickle-shaped, prominently 1-nerved. Lip short to obscurely short-clawed, more or less cuneate as in *L. convallarioides*, but with distinct small auricles above the claw. Apex of the lip cleft, the lobes 2-3 mm long.

Type: *F. W. Case* No. *62-150*, Alger Co., Michigan. Sandy wash in ravine below Sable Falls, ca. 1 mile west of Grand Marais, July 3, 1962. (Type in University of Michigan Herbarium; isotypes will be placed at Cranbrook Institute of Science and U.S. National Herbarium.)

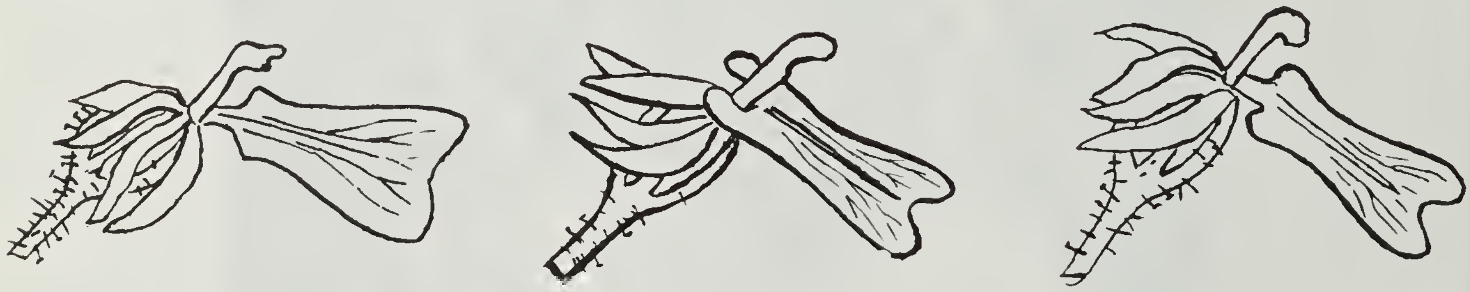

Fig. 2. Sketches of individual flowers showing differences in shape of the lip between (left to right) *Listera convallarioides*, *L. auriculata*, and *L.* × *veltmanii*.

Judging from the relative ease with which we found colonies of *L. auriculata* once we became familiar with its particular habitat, I suspect that the species will be found in suitable habitats along many of the larger streams and rivers in non-limestone districts of Upper Michigan. The Schoolcraft Co. colony found by Dr. Voss, in a Lake Michigan drainage, indicates that its distribution is not confined to the Lake Superior watershed. *L. convallarioides* is rather common in much of Upper Michigan. Undoubtedly, where both of these species occur in proximity, *L.* × *veltmanii* will be found again.

AN ECOLOGICAL STUDY OF A WET PRAIRIE ON HARSENS ISLAND, MICHIGAN[1]

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A prairie consists of an assemblage of shade intolerant herbs, mostly grasses, the deep roots or extensive rhizomes of which favor the survival of the plants following extended droughts or fire.

The rich soil characteristic of the prairie grasslands was plowed under and is presently covered by the extensive wheat and corn belts across the central states. This exploitation, along with overgrazing, has resulted in almost complete obliteration of the original vegetation.

A great deal of ecological work has been done on the prairies of the West. The most exhaustive review of the natural history of the grasslands is that of Malin (1956). Little work has been done on the ecology of the prairies of Michigan, however. Butler (1947, 1948, 1949), from early pioneer records, gives an indication of the size of the prairies that existed in southern Michigan in the early nineteenth century, but mentions only a few plants. Veatch (1928) surveyed the state for dry prairies, the distribution of which is shown in Figure 1. From field notes taken during the land survey of 1826 to 1832, Kenoyer (1930, 1934, 1940) has reconstructed, on the basis of the distance between witness trees and stakes driven into mounds built on the prairies, the original vegetation and extent of prairies in southwestern Michigan. The location of some prairie areas or listing of characteristic prairie plants was recorded in geological or botanical reports by Winchell (1861), Dodge (1900, 1911, 1914), (Cole 1901), Beal (1905), Gleason (1917), Houghton (in Fuller, 1928), Bingham (1945), and Hanes and Hanes (1947).

The only quantitative record of the various species, or an analysis of the environmental factors involved in the development of a Michigan prairie, has been the work of Hauser (1953) on the dry prairies of Newaygo County. Unfortunately in these areas the vegetation is so sparse that the U.S. Department of Agriculture, in order to make them more productive, is presently planting on federally owned land various species of pine throughout.

In view of the fact that so little analytical work has been done on the prairie vegetation of any kind in Michigan and that such areas are rapidly disappearing, the purpose of this study has been to locate for possible preservation and further study a wet prairie in southeastern Michigan, to determine for the first time in this region the relative dominance, frequency, and density of the various plants and the environmental factors involved in the development and maintenance of the community, and finally to compare it with prairies in other areas of Michigan and nearby states.

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[1] Contribution No. 113 from the Department of Biology, Wayne State University, Detroit, Michigan.

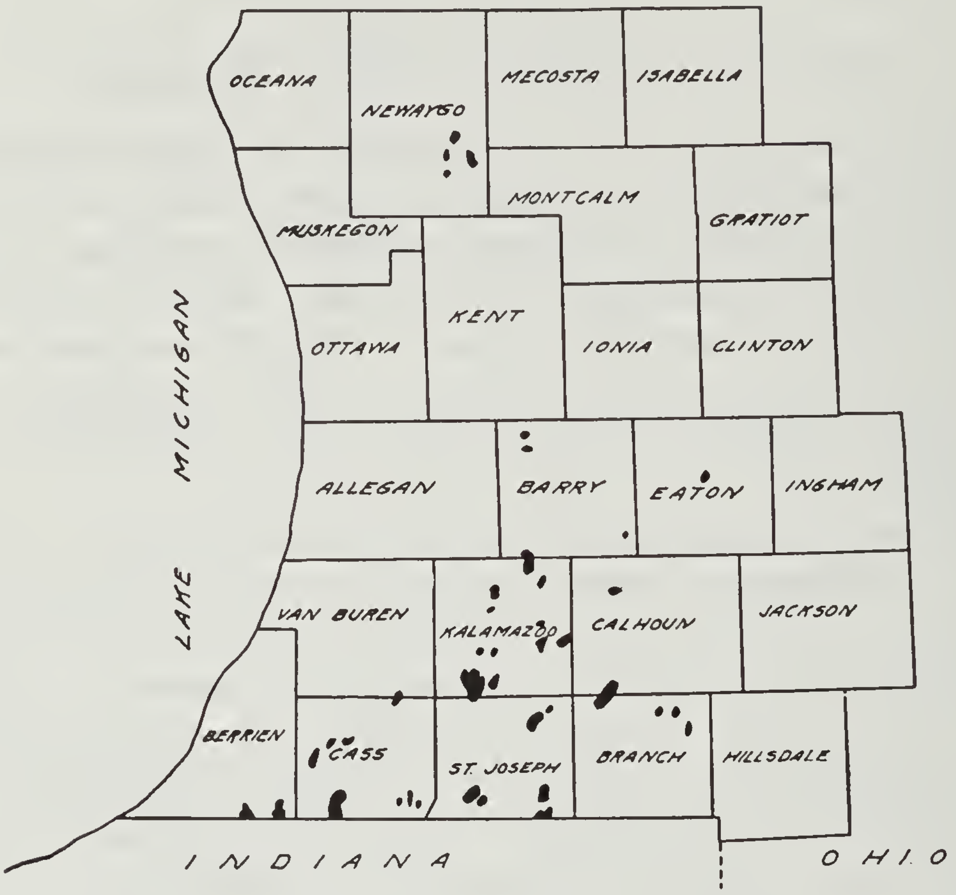
OCEANA
NEWAYGO
MECOSTA
ISABELLA
MONTCALM
MUSKEGON
GRATIOT
KENT
OTTAWA
IONIA
CLINTON
ALLEGAN
BARRY
EATON
INGHAM
VAN BUREN
KALAMAZOO
CALHOUN
JACKSON
BERRIEN
CASS
ST. JOSEPH
BRANCH
HILLSDALE
LAKE MICHIGAN
INDIANA
OHIO

Fig. 1. Distribution of dry prairies in southern Michigan (from Veatch, 1928).

LOCATION AND DESCRIPTION

In an attempt to locate prairie areas in southeastern Michigan, during the winter of 1958 I wrote to county agricultural agents requesting information concerning the existence of any prairie in their respective counties. This, together with a study of the U.S. Department of Agriculture's soil surveys for some of the southern counties, proved to be of little or no avail. A list of prairie indicators was compiled, and, using the herbaria of the University of Michigan, Michigan State University, Cranbrook Institute of Science, and Wayne State University, the collecting sites of specimens of these plants were determined and recorded. Using this information as a guide, after two summers in the field, a relatively undisturbed area with a good representation of prairie plants was found on Harsens Island, St. Clair County, Michigan.

Harsens Island, one of the delta islands known locally as "The Flats," is about three miles wide and five miles long (Fig. 2), and is serviced by an auto ferry near the city of Algonac, Michigan. The upper half of the island has several oak-hickory woodlots and one small woods of birch and sassafras. Leo B. Pospichal, the Michigan Department of Conservation's manager for the island, stated (personal communication), "the major crops are corn, wheat, rye, barley, oats, millet, buckwheat, soybeans and hay crops. Some livestock production is being carried on in cattle and hogs. The common animals on Harsens Island include: deer, cottontail rabbits, opossum, raccoon, red fox, skunk, mink, muskrat, weasel, fox squirrel, and a host of small rodents. European hares and badgers have been on the island in the past."

The upper parts of the delta islands are now three to five feet above mean water level. The upland soil of Harsens Island is composed of Colwood very fine sandy loam (Deeter, 1929), of which the upper fifteen inches is high in organic matter. According to records for a 39-40 year period (Wills, 1941), nearby Port Huron receives an annual precipitation of 26.98 inches; the average temperature in January is 23.6°F. and in July, 70.1°F.; while the average length of the growing season is 165 days.

The area under study is a privately owned fifteen acre tract of land, confined by drainage ditches, woodlots, and the fairways of the Mid-Channel Golf and Country Club. From about 1920 to 1934

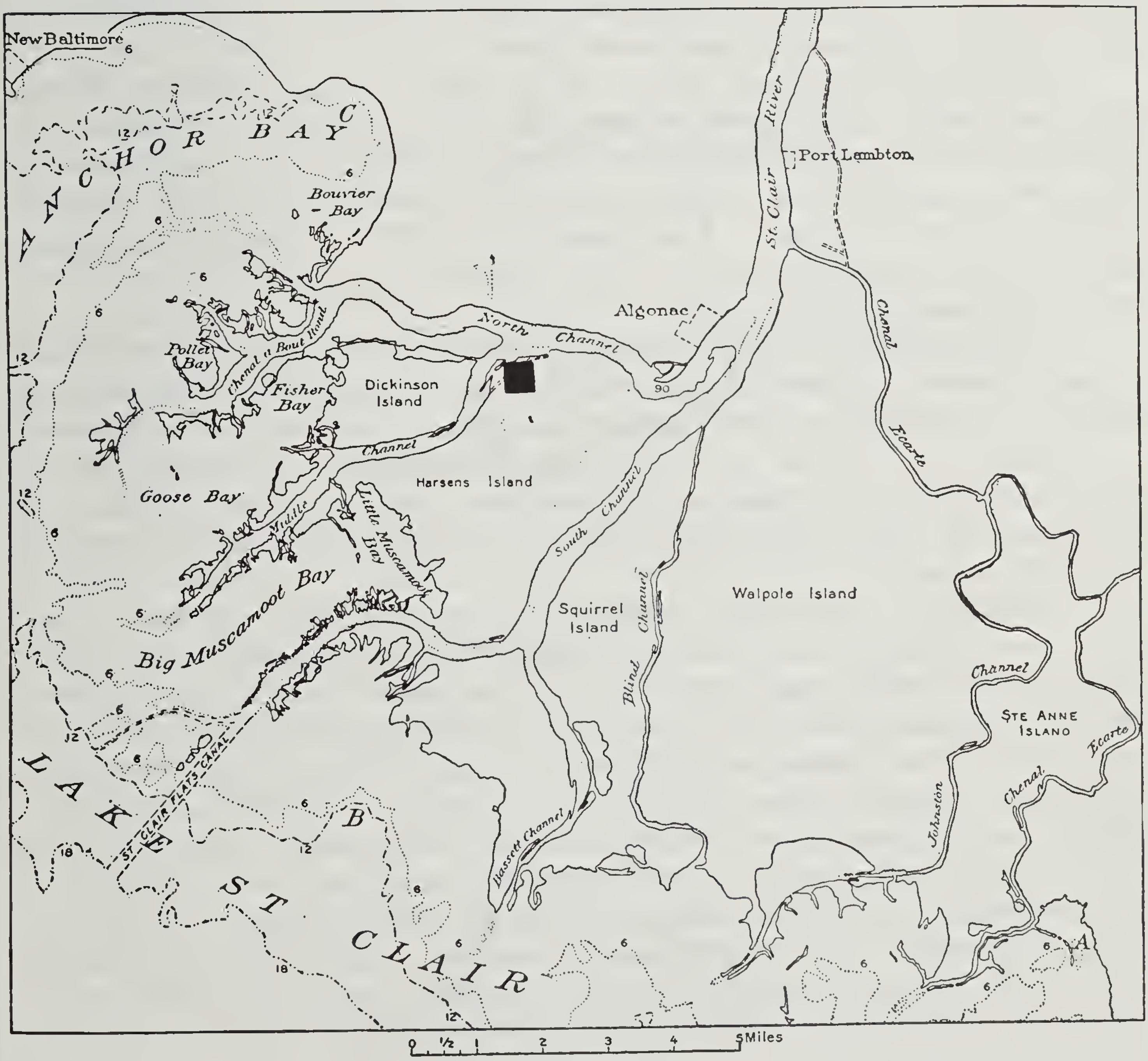
New Baltimore
ANCHOR BAY
C
Bouvier Bay
Pollet Bay
Chenal a Bout Rond
Fisher Bay
Dickinson Island
North Channel
Algonac
90
St. Clair River
Port Lambton
Chenal Ecarte
Channel
Harsens Island
Goose Bay
Middle Channel
Little Muscamoot Bay
Big Muscamoot Bay
South Channel
Squirrel Island
Blind Channel
Walpole Island
Channel
Ste Anne Island
Chenal Ecarte
Johnston Channel
Bassett Channel
St. Clair Flats Canal
LAKE ST. CLAIR
B
A
0 ½ 1 2 3 4 5 Miles

Fig. 2. The delta islands at the mouth of the St. Clair River, Michigan and Ontario, with the location of the wet prairie on Harsen's Island indicated by a square. (From Leverett and Taylor, 1915, p. 479.)

it was, in part, converted to fairways to form an eighteen-hole golf course and in part left intact, except for periodic burning. The fairways within the prairie were abandoned about twenty years ago, but the owners have continued burning the entire area at about two-year intervals.

Due to poor drainage conditions, about one half of the area was two or three inches under water in the spring of 1960. In the late fall of 1960 or early spring of 1961 the entire area was burned over. At the same time a change in the drainage system reduced the amount of standing water to less than one inch in the spring of 1961.[2]

METHODS

In May, 1960, ten one-meter-square quadrats were distributed so as to give a sampling throughout the prairie. At each site a pair of stakes was driven into the ground, and, at the time of each observation, a portable one-meter-square frame, constructed from aluminum tubing, was placed over them.

Every two or three weeks from May through October during 1960 and 1961, each quadrat was checked for plants in flower or identifiable vegetative condition. These plants were not removed from the quadrats, but voucher specimens were made from similar plants collected nearby. A permanent cumulative record of the plants seen in each quadrat was kept. The taxonomic nomenclature follows that of Fernald (1950).

In November, 1960, a strip of sod one decimeter wide by one meter long was removed from each of the ten quadrats. In the laboratory the strips of sod, each representing one tenth of a quadrat, were kept in a shallow pan and provided with water and light during examination of the vegetative groundlayer species. The number and frequency of the recognizable plants from the field and laboratory were tabulated.

In order to show the invasion of plants from the adjacent woodlot and to compare the types of plants found in the relatively undisturbed areas with those which have revegetated the abandoned fairways, a transect study was made. One hundred meters of wire extending from a drainage ditch at the edge of the woods across an abandoned fairway to the middle of the prairie, marked the transect. Square decimeters of sod were removed at one meter intervals along the transect and placed in their proper sequence in a shallow pan and provided with water and light during examination in the laboratory. Species of flowering plants growing within a one half meter radius of each one decimeter square sample, but not in the sample, were also recorded at the time of removal of the sod.

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[2] Since completion of this preliminary study, the owner said in the summer of 1963 that this area is to be plowed under in order to make an additional nine holes for the golf club.

Plants from the entire prairie area, as well as from similar habitats on the island, were collected, identified, and placed in the Wayne State University herbarium.

RESULTS AND DISCUSSION

The area is a nearly level tract with scattered irregular depressions a few inches deep and of one to several meters in extent. These depressions permit such otherwise infrequent plants as *Spartina pectinata, Calamagrostis canadensis,* and *Habenaria leucophaea* to survive individually or in colonies. There are several abandoned man-made "bunkers," which are covered with such weeds as *Cirsium discolor, C. muticum, Solidago nemoralis, S. altissima,* and *Rudbeckia hirta.* Locally, these plants have invaded the lower level of the prairie. A difference of about one foot in general elevation, between the highest and lowest parts of the prairie, plays an important role in the distribution and number of species. About 50 per cent of the area was inundated with two or three inches of standing water in the spring of 1960.

All of the species collected in the wet prairie, including those found within the quadrats, are shown in Table 1. Numbers 1 to 4 indicate rare to abundant.

QUADRAT STUDY

Quadrat 7 was at an elevation slightly higher than all of the other quadrats, and therefore was the driest. Quadrats 6, 8, and 9 were somewhat less dry; quadrats 1 and 2, and to a lesser degree 3 and 10, were extremely wet; the remainder were moderately moist during the spring and summer.

The results of the quadrat study, which are summarized in Figure 3, show the density and frequency of the most common species and represent about half of the total list for the quadrats (Table 1). Typical of most wet and mesic prairies is the high density of *Andropogon gerardi, A. scoparius, Aster ericoides, Panicum virgatum,* and *Sorghastrum nutans.* The comparatively low frequency of *Andropogon scoparius* is due primarily to its intolerance of the wet areas. Other plants which showed a strong affinity for the drier sites of quadrats 6, 7, 8, and 9 were *Achillea millefolium, Equisetum arvense, Desmodium canadense, Melilotus alba, Poa pratensis, Solidago nemoralis,* and *Vernonia missurica.*

Those plants found in only the more extreme wet areas were *Eleocharis elliptica, Erigeron philadelphicus, Gerardia purpurea, Hypoxis hirsuta, Juncus balticus, Lobelia spicata, Helenium autumnale, Sisyrinchium mucronatum, Senecio aureus,* and *Solidago ohioensis.* Some of the plants that were able to tolerate both the extreme wet and dry areas and, thus, were found throughout the area were *Agrostis alba, Andropogon gerardi, Aster dumosus, Carex crawei,* *Fragaria virginiana, Liatris spicata, Lysimachia quadriflora, Panicum lanuginosum, Panicum virgatum, Pycnanthemum virginianum,* and *Sorghastrum nutans.*

Andropogon gerardi, in terms of abundance, ground coverage, and control of shade-intolerant herbs, is the most important single species in the community. In the more moist areas this dominance

TABLE 1. Total List of Plants Collected in the Wet Prairie of Harsens Island

An asterisk (*) indicates a species found in one or more of the quadrats. The numbers 1, 2, 3, and 4 refer, respectively, to plants judged to be rare, infrequent, frequent, and abundant.

*1 Equisetum arvense L.
*4 Agrostis alba L.
*4 Andropogon gerardi Vitman
*4 A. scoparius Michx.
2 Calamagrostis canadensis (Michx.) Nutt.
1 Glyceria striata (Lam.) Hitchc.
1 Panicum commutatum Schultes
*4 P. lanuginosum Ell.
1 P. leibergii (Vasey) Scribn.
*4 P. virgatum L.
*3 Poa pratensis L.
*4 Sorghastrum nutans (L.) Nash
2 Spartina pectinata Link
*2 Carex buxbaumii Wahlenb.
*4 C. crawei Dew.
2 C. lanuginosa Michx.
*3 C. tetanica Schkuhr
*4 Eleocharis elliptica Kunth
2 Scirpus lineatus Michx.
*3 Juncus balticus Willd.
2 J. dudleyi Wieg.
2 J. torreyi Coville
*2 Hypoxis hirsuta (L.) Coville
1 Iris versicolor L.
*2 Sisyrinchium mucronatum Michx.
1 Habenaria leucophaea (Nutt.) Gray
*2 Spiranthes cernua (L.) Richard
1 Populus deltoides Marsh.
1 Quercus macrocarpa Michx.
1 Q. palustris Muenchh.
1 Ulmus americana L.
2 Comandra richardsiana Fern.
1 Anemone canadensis L.
1 Crataegus crus-galli L.
*3 Fragaria virginiana Duchesne
*2 Potentilla anserina L.
1 Prunus sp.
1 Rosa blanda Ait.
1 R. carolina L.
*2 Desmodium canadense (L.) DC.
*2 Lathyrus palustris L.
*1 Melilotus alba Desr.
*3 Viola affinis LeConte
*2 Lythrum alatum Pursh
1 Cicuta maculata L.
1 Zizia aurea (L.) W.D.J. Koch
*2 Cornus racemosa Lam.
*4 Lysimachia quadriflora Sims
1 Fraxinus pennsylvanica Marsh.
1 Gentiana andrewsii Griseb.
1 G. procera Holm
*2 Apocynum cannabinum L.
1 Asclepias incarnata L.
1 A. sullivantii Engelm.
1 A. syriaca L.
*1 Convolvulus sepium L.
2 Verbena hastata L.
*2 Lycopus americanus Muhl.
1 Monarda fistulosa L.
*2 Prunella vulgaris L.
*3 Pycnanthemum virginianum (L.) Dur. & Jack.
2 Stachys tenuifolia Willd.
*2 Gerardia purpurea L.
1 Penstemon digitalis Nutt.
1 P. hirsutus (L.) Willd.
*2 Veronicastrum virginicum (L.) Farw.
1 Galium boreale L.
1 G. obtusum Bigel.
1 G. tinctorium L.
*3 Lobelia spicata Lam.
*2 Achillea millefolium L.
*4 Aster dumosus L.
*4 A. ericoides L.
2 A. novae-angliae L.
1 Cirsium discolor (Muhl.) Spreng.
1 C. muticum Michx.
*3 Erigeron philadelphicus L.
1 E. strigosus Muhl.
2 Eupatorium maculatum L.
1 E. perfoliatum L.
*2 Helenium autumnale L.
1 Helianthus giganteus L.
*3 Liatris spicata (L.) Willd.
1 Prenanthes racemosa Michx.
*3 Rudbeckia hirta L.
*3 Senecio aureus L.
1 Solidago altissima L.
2 S. graminifolia (L.) Salisb.
*1 S. nemoralis Ait.
*2 S. ohioensis Riddell
*1 S. riddellii Frank
*3 Vernonia missurica Raf.

is shared with *Panicum virgatum* and in the drier areas with *Andropogon scoparius*. The complete absence of such common field weeds as *Antennaria, Plantago,* and *Verbascum,* which form basal rosettes of leaves, is probably due to spring flooding of the area, or to the shading effect of the grasses in the drier sites. Annuals, which must develop from seed each year, also cannot compete successfully with the perennials. Of a total of ninety-two species collected in the prairie, only six annual species were found. The identification of the seedlings from the one decimeter by one meter strips, that were removed from each of the quadrats, did not significantly add to the counts of the more mature plants in the quadrats, but it did indicate a ground coverage of up to 50 per cent of an unidentified resupinate moss in six of the quadrats. Quadrats 1, 2, and 10, which were under water in the spring of 1960, and quadrat 7, because of its higher elevation and continued dryness, had less than 10 per cent.

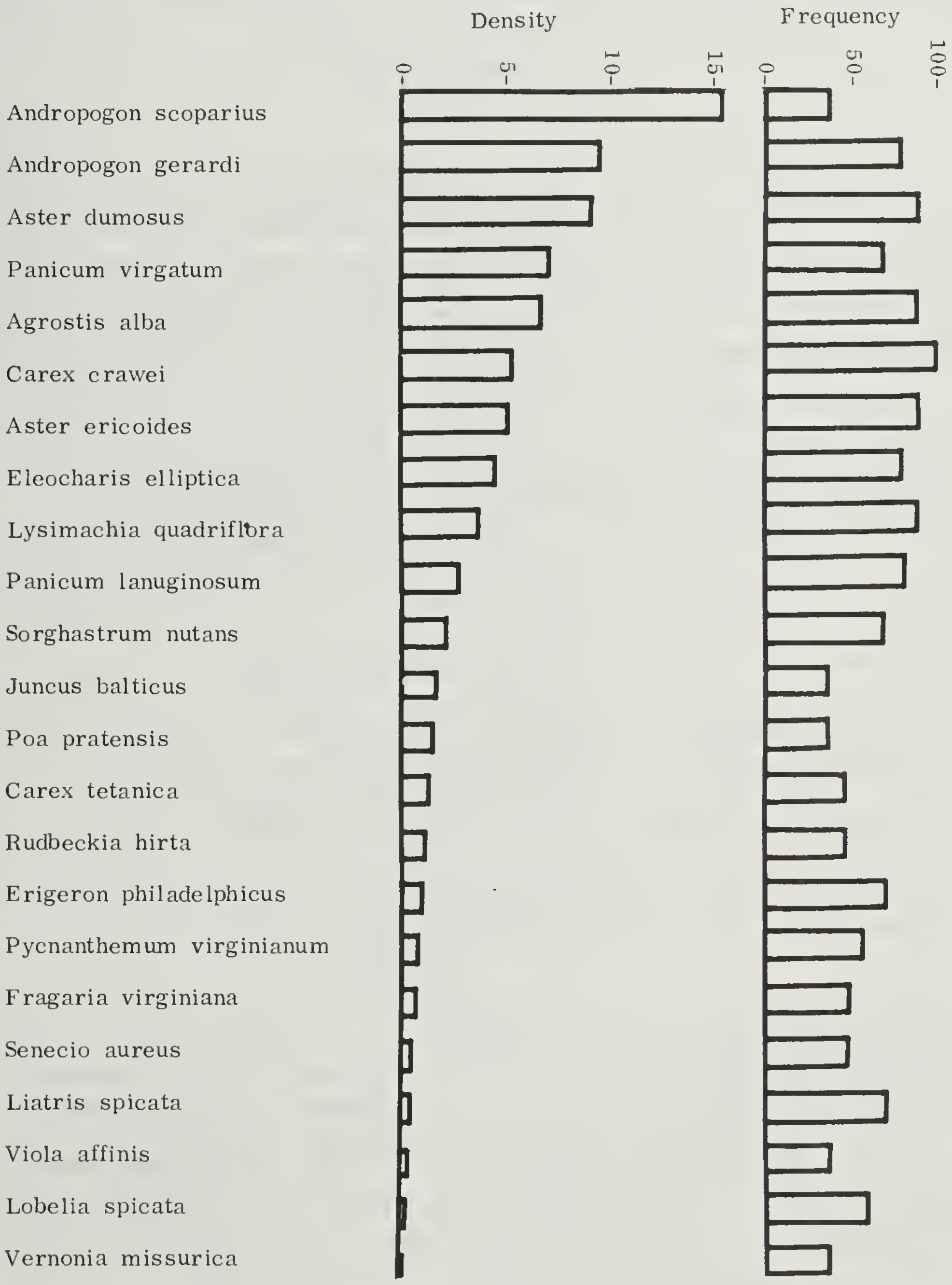

Fig. 3. Density and frequency of the most common species found in ten one-meter-square quadrats.

Carex sp., *Panicum lanuginosum*, *Lysimachia quadriflora*, and *Panicum virgatum* were found to be among the most common seedlings in the flooded-over areas.

TRANSECT STUDY

The transect, which extended from the adjacent woodlot toward the center of the prairie, included an abandoned fairway and the adjacent "roughs." The latter, presumably, have never been disturbed except by fire.

The vegetation of the abandoned fairway and rough is indistinguishable, because the old fairway has become completely reestablished with the original vegetation. The reasons for this are probably due to the close proximity of the original vegetation, allowing effective seed dispersal and invasion by rhizomes, and the periodic burnings, which have prevented invasion and permanent establishment of weeds and of woodland plants. It is not likely that the rhizomes,

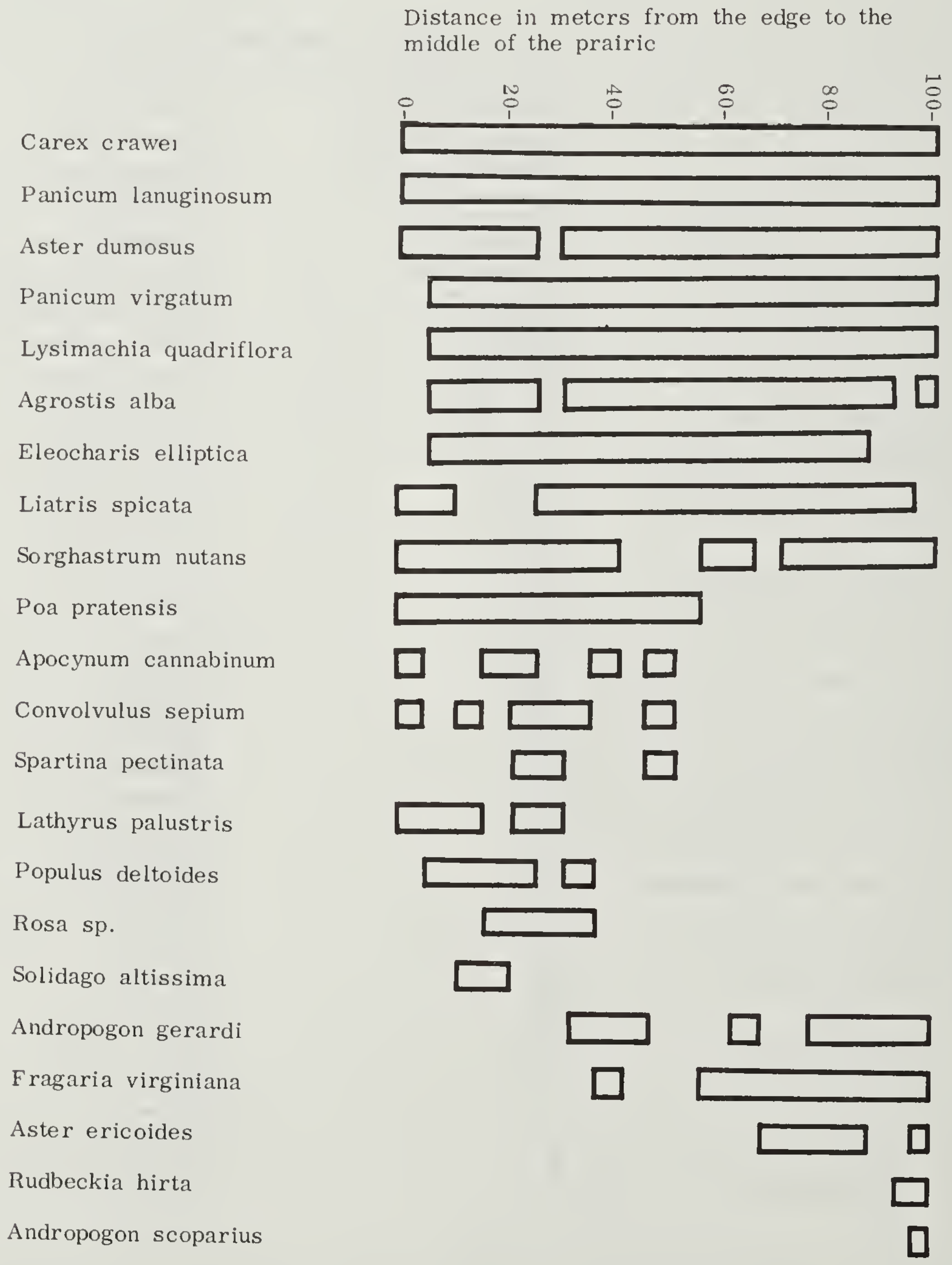

Fig. 4. Distribution of selected species along a 100 meter transect.

left after plowing and the close cropping by mowers, would have survived the many years that the fairway was in operation.

Figure 4 shows the distribution of selected species along the transect. That part of the transect farthest from the woodlot was the driest. The plants which were found all along the transect were, as would be expected, among those of the highest frequency and density in the quadrat study.

Some species found mainly in the driest part of the transect are *Andropogon gerardi, Fragaria virginiana, Aster ericoides, Rudbeckia hirta,* and *Andropogon scoparius.* These plants can tolerate the higher transpiration that is to be expected of an open area exposed to the sun and winds.

Those plants that seem to be best adapted to the moist shadier area of the woodlot-field ecotone are *Poa pratensis, Apocynum cannabinum, Convolvulus sepium, Spartina pectinata, Lathyrus palustris, Populus deltoides, Rosa sp.,* and *Solidago altissima.* Some of these appear to be transient invaders between burnings.

EFFECT OF FIRE

After the first year of collecting and recording of species, the area was burned. The only woody plant to survive was *Crataegus crus-galli,* which did not produce fruit the following year. *Cornus racemosa* and *Populus deltoides* did reappear the following year near the woodlots from seed or from incompletely burned stubble. Before the burning there was no evidence, except for *Crataegus,* that any tree species had survived three or more years within the prairie area. The new growth did not indicate any substantial change in the abundance or frequency of species seen during the year preceding the burning.

COMPARISON WITH OTHER AREAS

The assemblage of plants that are indicative of the western and central prairies becomes decimated in eastern United States to the extent that they constitute less than ten per cent of the species that can be found in any plant community in Michigan. In the state the largest number of these plants are found adjacent to oak-hickory woodlots.

Because of the regional distribution of species and the difference in size and number of stands from which quantitative records have been made in other prairie areas, a good comparison of these with the one stand from Harsens Island cannot be made.

Hauser (1953), selecting fifty plots comprising 500 quadrats in the prairies of Newaygo County, Michigan, found 117 species. Only 17 of these are present in the prairie of Harsens Island. Such plants as *Andropogon gerardi, A. scoparius, Aster ericoides,* and *Poa pratensis,* typical of the dry sandy prairies of Newaygo, are found in the drier sites of the prairie on Harsens Island.

Curtis (1959) describes five types of prairies found in Wisconsin. Of these, the environmental conditions most closely paralleling those found in this study were those of the wet-mesic prairies, for which he describes the following features: an abrupt change from the rich organic topsoil to a layer of impeded internal drainage or clay; the uneven surface of hummocks that are up to a foot higher than the intervening land; a lowland, subject to inundation by heavy rains; and a high stability, as a community, in the presence of fire, but otherwise replaced by a southern wet-mesic forest. For the wet-mesic prairie he lists only the 82 most prevalent species, of which 30 are found in the prairie of Harsens Island. Of these, *Habenaria leucophaea, Sorghastrum nutans,* and *Spartina pectinata* are found in the wet areas on Harsens Island, while *Andropogon scoparius* and *Aster ericoides* are of high frequency, particularly in the drier sites. Plants which are generally frequent in both regions are *Fragaria virginiana* and *Pycnanthemum virginianum.* The most important species common to the two areas is *Andropogon gerardi,* the dominant plant in both localities. Of special interest is *Habenaria leucophaea,* which Curtis has recorded only for the wet mesic prairie.

The data for the climate of the prairies of Newaygo County, Michigan, Wisconsin, and the prairie of Harsens Island are essentially the same. The desert-like soil of Newaygo County is poor in comparison with the rich bottomland soil of the Wisconsin wet mesic prairie and that of Harsens Island.

In the Geological Reports of Douglas Houghton (Fuller, 1928) of 1839, many prairie areas were noted for Monroe, Oakland, and Wayne counties. Of special interest are the prairie relicts of nearby Walpole Island and Squirrel Island. The Indians on the reservation on these islands maintained much of the original vegetation by burning. Dodge (1914) lists about one hundred plants from these islands, of which forty including *Koeleria cristata, Stipa comata, Habenaria leucophaea, Asclepias sullivantii, Lithospermum canescens, Solidago rigida,* and *Silphium terebinthinaceum* may be considered as characteristic of the western prairies. Of these plants only *Habenaria* and *Asclepias* are found on Harsens Island.

CONCLUSIONS

The prairies offer the finest agricultural lands in the United States. Their discovery and depletion have resulted in the term "prairie relict" for those communities which still have a vestige of the plants that once inhabited the original prairies. In Michigan, relicts of former dry prairies exist principally in Newaygo County.

Most plants indicative of the dry or mesic prairies such as *Sporobolus heterolepis, Bouteloua curtipendula, Amorpha canescens,* and *Coreopsis palmata* are either no longer found in Michigan, or are found only along railroad tracks, roadsides, or in abandoned weedy fields.

The results of an ecological study, which lasted over two growing seasons, indicate the presence of a plant community on Harsens Island comparable to the wet mesic prairies of Wisconsin. The presence of *Habenaria leucophaea* and a high frequency and density of the prairie grasses, as *Andropogon gerardi, A. scoparius, Panicum virgatum,* and *Sorghastrum nutans,* probably provide the best leads to the discovery of more such areas in Lower Michigan. The climate and soil do not favor the existence of the wet prairie any more than they do that of the adjacent marshes and oak-hickory woodlots. The burning over of the entire area at two-year intervals and its partial flooding by the spring rains are primarily responsible for the existence of this wet prairie.

SUMMARY

Using information obtained from herbarium collections of prairie indicators, a wet prairie was discovered on Harsens Island, Michigan.

In order to determine the frequency and density of the plants within the prairie, ten one-meter-square quadrats were permanently staked out, and the plants recorded over two growing seasons. Those plants with the highest density were, in descending importance, *Andropogon scoparius* (Little Bluestem), *A. gerardi* (Big Bluestem), *Aster dumosus* (Strict Aster), *Panicum virgatum* (Switch Grass), *Agrostis alba* (Redtop), *Carex crawei* (Crawe's Sedge), *Aster ericoides* (Heath Aster), *Eleocharis elliptica* (Slender Spike Rush), *Lysimachia quadriflora* (Narrow-leafed Loosestrife), *Panicum lanuginosum* (Panic Grass), and *Sorghastrum nutans* (Indian Grass). The most important species in terms of ground coverage and abundance was *Andropogon gerardi.* In the drier sites this dominance was shared with *Andropogon scoparius* and in the more moist sites with *Panicum virgatum.*

A one hundred meter transect study extending from the adjoining woodlot to the middle of the prairie was made, in order to determine the invasion of plants from the woodlot and revegetation of the fairways that once existed within the prairie. The results indicate that such weedy plants as *Apocynum* (Indian Hemp), *Convolvulus* (Hedge Bindweed), *Populus* (Cottonwood), and *Rosa* are confined to the woodlot-prairie ecotone, and a high frequency over the entire one hundred meters of many of the plants that were of high frequency and density in the quadrat study. There was no evidence left that an abandoned fairway ever existed there, because of the high frequency all along the transect of the species that were abundant throughout the prairie.

Because of the burning over of the entire area at two-year intervals, there was no evidence of any woody plant, other than *Crataegus crus-galli* (Hawthorn), that had lived over a three year period.

The climatic and edaphic factors offer little explanation for the persistence of the wet prairie. The existence of this plant community is due primarily to the periodic burning and the inundation by spring rains which prevent the establishment of woodland species. The plants recorded appear to be an assemblage of marsh and prairie species, which persist as a wet prairie.

ACKNOWLEDGMENTS

I wish to express my gratitude and appreciation to Dr. C. M. Rogers for his guidance, throughout the course of this study, and to Jarl K. Hiltunen, who was my almost constant companion during the search for prairies in Michigan. For information about Harsens Island my thanks to Leo Pospichal, of the Michigan Department of Conservation. For permission to work on the golf course property, I am especially grateful to Emmanuel Z. Manos.

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NOTES ON INTERESTING MUSHROOMS FROM THE UPPER PENINSULA

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Although it has been said that mushrooms are "where you find them" it is natural for collectors to desire information on the best places in which to hunt—if such knowledge is available. For this reason we are instituting a series of notes on mushrooms from the Upper Peninsula. The south shore country of Lake Superior is one of the world's truly interesting areas for fleshy fungi, but as far as the area from Marquette west is concerned, it is still relatively unexplored for these plants. The situation is being remedied by the activities of local collectors, the interest of the Huron Mountain Club through its Wildlife Foundation, and collecting from the University Herbarium of the University of Michigan preparatory to a manual of the fleshy fungi of Michigan.

Because of the rapidly developing interest in mushrooms it appears desirable to publish notes, not particularly on the rare fungi, but on the striking and common species that the hunter is certain to find but which for the most part are not included in such publications as *The Mushroom Hunter's Field Guide* or *Some Common Mushrooms of Michigan's Parks and Recreation Areas*. Many of our readers who do not live in the Upper Peninsula often vacation there during the best part of the mushroom season.

Boletus edulis Fr.

This prize edible fungus has generally been regarded as very rare in Michigan, but to our knowledge more of it has been found in the vicinity of Marquette than at any other locality. Now that the location where it grew has been subdivided, with the usual destruction of the habitat as far as native plants go, we are not giving away any secrets by revealing that up until recently the best locality for it in Michigan was right in the city of Marquette at the edge of a stand of conifers. We mention this here because it is a good illustration of several aspects of mushroom hunting: 1) You need not (necessarily) travel long distances to find the best mushrooms. 2) The occurrence of the various species, especially those living in the soil, is often very "spotty"—you find one small area here, and then another perhaps 20 miles away. This keeps the mushroom hunter hunting for he has no way of knowing in advance exactly where certain mushroom plants have become established. Incidentally, we would be interested in learning about other spots where *Boletus edulis* occurs—and will promise not to reveal anything about them.

Boletus projectellus Murrill

This is a conspicuous species found mostly in the southeastern states; hence its occurrence near Marquette on the south shore of Lake Superior is of great interest. The species is well illustrated in Coker & Beers. The surface of the cap reminds one very much of the western *Boletus mirabilis* which occurs sparingly in the Upper Peninsula of Michigan and which may at times have a wide-meshed obscure reticulation over the upper part of the stipe the same as for *B. projectellus*. As Singer so aptly pointed out, *B. projectellus* has about the largest spores of any bolete known (22-30 × 8-12 μ). The spores are smooth and rather rich clear yellow as revived in KOH. Singer placed this species along with *B. mirabilis* in *Boletellus*. (*Bartelli 2156, 2157*)

Fuscoboletinus glandulosus (Peck) Smith & Pomerleau

The Marquette record is the most westerly extension of the range of this species in the United States. It has also been found in the vicinity of the lower falls in Tahquamenon Falls State Park, but never abundant. However, it is common in the Laurentides Park in Quebec and also in Nova Scotia, indicating that it is a species with primarily a northeastern distribution. The cap is dull rusty red and viscid, the pores are yellow, the veil is glutinous, but most distinctive of all the spore deposit is dark dull lilac, not at all like that of most viscid boletes. (*Bartelli 2048*)

Kuehneromyces rostratus Singer & Smith

Some comment on this species is in order, in view of the fact that not much is known about it other than the information contained in the original account. In the hardwood forests north of Harbor Springs and west of Pellston, this species is found repeatedly in late May and June, or even early July, growing solitary or in small clusters on decaying hardwood logs and stumps. We have come to regard it as much a part of vernal mushroom flora as the morels, or the early whitish oyster mushroom on aspen. In the slashings south of the Tahquamenon River, particularly those on the road into Whitehouse Landing, it has also been found abundantly on occasion, but here it has occurred on old logs and is more often cespitose. However, Mrs. Bartelli has found it in almost unlimited quantity on and around sawdust piles along the south shore of Lake Superior, particularly between Big Bay and Marquette. Here the species occurs in massive clusters, if the weather is right, and some people will certainly wonder if it is edible. We have, as yet, no reliable data on this point, so we would caution anyone against trying it.

It can be recognized by its honey-brown cap, thin often ragged ring on the stalk, and rusty brown gills. It is quite possible that the poisonous *Galerina autumnalis*, which fruits in the spring as well as the fall, will occur at times in the same habitats. It has all the characters mentioned above, but in addition has a more slender stalk. However, the danger of confusing these two is very great, which is an additional good reason for our not wanting people to experiment with *K. rostratus*. We believe that the differences in fruiting habit we have noted are directly attributable to the differences in nutrition, sawdust offering almost unlimited potential for fruiting body production. The material illustrated in Singer & Smith's original account came from along a road bank composed of sawdust and soil used for a fill, and shows the luxuriant type of growth form.

Lepiota americana Peck

This is a medium to large *Lepiota* of ordinary appearance when fresh. The cap has a dull to reddish brown cuticle which breaks up into scales; the stalk is reddish where handled, and the gills are white until discolored by age. The distinctive feature is that on drying the whole fruiting body becomes reddish, actually a dull vinaceous red. Kauffman reported it as apparently rare in Michigan and this is certainly in line with Smith's experience in the state. In the Marquette area however, at least in the one mill yard, it has been consistently abundant over a period of years. Kauffman lists it as edible but we both take a dim view of eating large Lepiotas generally, because there is always the chance of getting the green-spored *Chlorophyllum molybdites*. This species is easily recognized in age by the green gills, and *L. americana* by the change to red, but it is the young caps which have as yet not developed either of these features that one desires for food. Hence the danger of making a mistake.

Lepiota brunnea Farlow & Burt

The collection by Mrs. Bartelli practically matches the excellent figures in *Icones Farlowianae*, Pl. 6. The color change in American material which we have seen is typically to brown though some red may show at first. In contrast, Kühner & Romagnesi give the color change for *L. rhacodes* as rose-incarnate or saffron-orange, which would appear to be quite a different reaction. Since it is not our purpose here to attempt a critical analysis of the variants of the *L. rhacodes* group and their world distribution, we are simply using the American concept which appears to fit our material perfectly. Although this is an excellent edible fungus we cannot recommend it because of a poisonous species, *Chlorophyllum molybdites*, which is easily mistaken for it in spite of the fact that the *C. molybdites* has green spores. (*Bartelli 2655*)

Pholiota kauffmaniana Smith

This species has generally been referred to as *Pholiota* *flammans* Fr. The question remains as to just how distinct the two actually are. The European form (or species) is said to have a dry to moist but not viscid cap whereas the American variant has a viscid cap. The difference appears to be one of degree of gelatinization of the cuticle. The problem is how much emphasis can be put justifiably on this point, and are there any correlated characters such as different color reactions with application of chemicals? The collector, however, will always remember this species as one of the most beautiful fungi he has seen because of the scales on the cap and stalk and the brilliant sulphur yellow color of all parts. (*Bartelli 2119*)

Stropharia rugoso-annulata Farlow in Murrill

This is our largest *Stropharia,* the caps reaching 15 inches broad at times. It is close to *S. hornmannii* which grows mostly on conifer wood and is not uncommon in the Marquette area, but is distinguished by the two-layered annulus, the underside of which typically splits radially into segments. Under the microscope the epicutis of the pileus is a tangled turf of gelatinous hyphae the contents of which are smoky-brown as revived in KOH. *S. rugoso-annulata* is not commonly found but when it does fruit one can usually collect it by the bushel. It is to be expected on chip-dirt, mulch made from bark, and around old sawdust piles. John Cage and other members of the New York Mycological Society have found it in quantity in New Jersey. It is edible as far as is known but we do not recommend it. (*Bartelli 2053*)

Stropharia squamosa var. *thrausta* (Schulz in Kalchbr.) Lange

The var. *thrausta* is a very rare fungus in the North Central States according to our experience, and this is apparently the first record of it from Michigan. The field characters are the orange-red cap which is squamulose from veil remnants at first, the broad dull purplish gills at maturity, and the pallid squamose stalk up to the more or less distinct annulus. (*Bartelli 2042*)

NATURAL HYBRIDIZATION IN THE GENUS CIRSIUM — II. C. *ALTISSIMUM* × C. *DISCOLOR*[1]

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The occurrence of natural hybridization in the thistle genus *Cirsium* has been a subject of interest to the writer for several years. One well documented case of hybridization between *C. discolor* and *C. muticum* was reported previously (Ownbey, 1951) and numerous other instances of the spontaneous formation of hybrids between these species have since been observed in the vicinity of Minneapolis, Minnesota. It appears, however, that hybridization among species of *Cirsium* native to eastern North America is not frequent and there is little or no evidence that it plays a significant role. One possible exception to this generalization is found in the complex which includes *C. altissimum, C. discolor,* and their intermediates.

The incidence of natural hybridization among species of *Cirsium* in western North America may be somewhat higher. J. T. Howell (1943, 1960) makes particular reference to numerous instances of probable hybridization among Pacific coast species. Somewhat earlier, P. A. Rydberg (1910) described a large number of putative hybrids, principally from Colorado. During my own collecting trips to the Rocky Mountain states, I have observed several additional instances of hybridization in *Cirsium.* It is evident at this stage that an appraisal of the significance of hybridization in western North American thistles must await the completion of more extensive studies than those published to date.

R. A. Davidson (1963) recently published a very provocative statistical analysis of variation in *C. altissimum, C. discolor,* and their intermediates. His study was based upon a series of herbarium specimens which were, with three exceptions, collected in Iowa. Among four characters shown to have discriminatory value in separating the two species, viz., height of involucre, style length, corolla lobe length, and leaf-lobing index, the last named had the highest value by far. The present study, carried out at about the same time but independently of those of Dr. Davidson, provides direct evidence of natural hybridization. It should be emphasized, however, that this study was based upon a single local population. It is still an open question whether hybridization between the two species has been an important factor in producing the intermediate forms present over much of their ranges. There is a strong presumption that it has.

Cirsium altissimum (L.) Spreng. and *C. discolor* (Muhl.) Spreng. are wide-ranging eastern North American species which have approximately sympatric distributions. Although their habitats have been disrupted over enormous areas by agricultural activities, it is still possible to observe slight differences in their habitat optima at less disturbed points in their ranges. Most important among habitat differences seems to be the tendency of *C. altissimum* to grow in forested areas in partial shade and the tendency of *C. discolor* to grow in open meadows and along roadways in full sun. Both require moist but well-drained soil and neither is found in very wet or very dry habitats. The effects of clearing for purposes of farming upon *C. altissimum*, particularly in the Midwest, have not been fully assessed. Some evidence exists that selection has favored the preservation of types capable of thriving in full sun. It should be noted, however, that the plants of *C. altissimum* contributing to the present study were of the typical shade-tolerant type found throughout the northeastern parts of the United States.

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[1] This investigation was supported by the National Science Foundation, Grant No. G9071. Miss Wilma Monserud prepared the figures.

Materials for the present study were collected from a mixed population of *C. altissimum* and *C. discolor* growing along a highway right-of-way in Barron County, Wisconsin, about nine miles east of Cameron. The site had been cleared recently of deciduous woods preparatory to periodic mowing. It may be supposed that *C. discolor* invaded the site during the two or three years between clearing and the first mowing. *C. altissimum* presumably already was present in the woodland. In any case, a situation conducive to hybridization was provided and conditions in the new habitat seem to have been optimal for the survival of the hybrids. When the mixed population was discovered by myself and my late wife, Marion (Findley) Nicholson Ownbey, in August, 1959, putative hybrids as well as both parents were very abundant for a distance of about two hundred feet along the south side of the right-of-way. The site was revisited by the writer and Dr. Yu-tseng Hsi on Aug. 31, 1959, when preliminary observations were made and a population sample obtained (*Ownbey & Hsi 2855*). We also obtained a second sample from another mixed population situated about 1.5 miles east of Almena, Barron Co., Wisconsin, on the same day (*Ownbey & Hsi 2856*). Since the circumstances under which the second population occurred paralleled those at the first site and later analysis showed almost identical results, a detailed report of the study of the second population was felt to be unnecessary and has not been included in this paper.

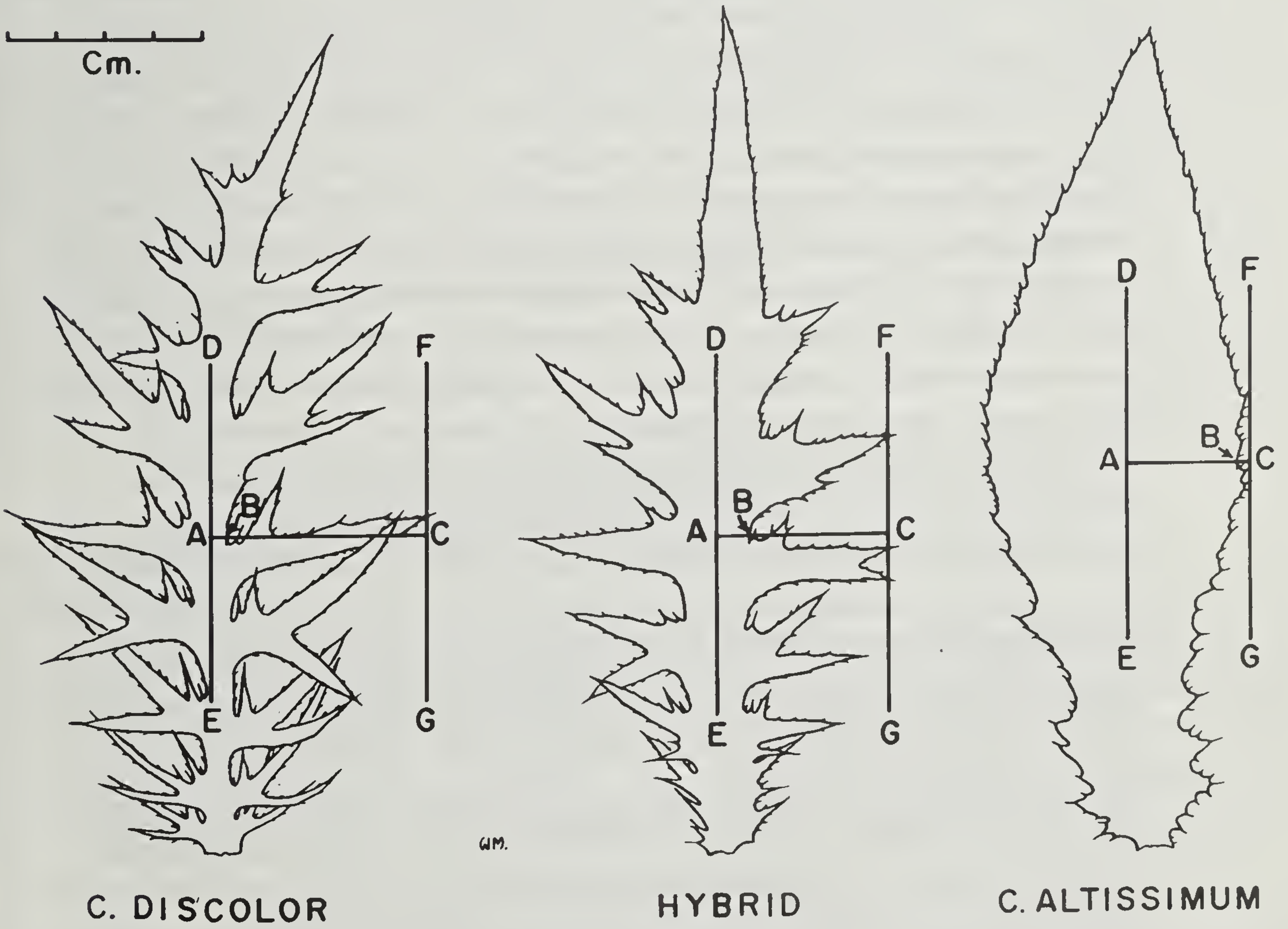
SAMPLING METHODS

A randomized sample of the population was made according to the grid method. As is customary, specimens were taken from the plant nearest the point of intersection of the grid lines. Ordinarily no plant farther removed than half the distance to the adjacent points was sampled, or if no plant was present within this distance the nearest unsampled plant was selected.

Since, as is frequently observed, *C. altissimum* and *C. discolor* are most easily distinguished by the degree of lobing or indentation of their leaves, it was thought that a population containing both species and their putative hybrids might best be studied by devising a method for expressing differences in leaf lobing. Two to four middle cauline leaves of each plant, therefore, were collected and pressed. The sampling of the population was completed by making specimens of the upper parts of each plant. Care was taken to obtain both flowering heads and heads that would normally contain mature achenes.

ANALYSIS OF POPULATION SAMPLE 2855

After inspection of the leaf samples it was decided that the most satisfactory and simplest way to measure the degree of lobing of the leaves was to calculate the ratio between the length of the longest lobe near the middle of the lamina and the distance between the midrib and the bottom of the sinus immediately above the longest lobe. It appeared that the best way to obtain the desired measurements was to run an imaginary line along the midrib, line DE, Fig. 1,



C. DISCOLOR HYBRID C. ALTISSIMUM

Fig. 1. Method used for obtaining leaf lobing and indentation percentage values for *C. discolor*, the hybrids, and *C. altissimum*. In each case the value was obtained by dividing BC by AC.

then to run another line, FG, parallel to DE through the apex (excluding the apical spine) of the longest lobe. Another line, AC, was then run perpendicular to DE through point B at the bottom of the sinus above the longest lobe, A being the point of intersection with the line DE and C being the point of intersection with line FG. Actual distances AB and BC could be read directly from a millimeter scale and the ratio BC/AB calculated. This procedure is similar but not identical to that devised by Dr. Davidson. It was later decided to express the length of the longest lobe as a percentage, distance BC of AC, because of the greater ease of recording the value on the bar graph, Fig. 2. It is obvious that with this method the angle of divergence of the longest lobe from the midrib was not taken into account and that lobes of different leaves having different angles of divergence might yield the same percentage value when the absolute length of the lobes differed correspondingly. It was not thought, however, that this feature constituted a serious source of misrepresentation although it must be admitted that actual leaf outlines were not being compared in a precise sense.

The next step was to arrange the data on a bar graph, Fig. 2, in descending order of percentage value of leaf lobing or indentation, from the highest value on the left, *C. discolor,* to the lowest value on the right, *C. altissimum.* If the putative hybrids were, as supposed, intermediate in degree of lobing then these plants should fall somewhere in between the two extremes. Their identity might be established with some certainty by adding bars for percent of normal pollen matured and for achene maturation. This was subsequently done, the values for pollen maturation being determined by means of ordinary staining techniques, and those for achene maturation by counting the mature achenes in two heads and dividing by the total number of flowers in the two heads. The data assembled in preparing the bar graph are summarized in Table 1.

DISCUSSION

The amount of sterility between plants of closely related species varies widely. If the sterility barriers are weak, other barriers to hybridization must function if the species are to maintain their individuality. In the absence of hybrid sterility one must, perforce, rely more heavily upon statistical analysis of morphological variation in identifying natural hybrids. If, however, the species possess a fairly high level of interspecific incompatibility, this will be reflected

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Fig. 2. Bar graph depicting Population Sample 2855. Leaf indentation or lobing percentage values for the individual plants were arranged in descending order from left to right. Bars for percentage of pollen grains reaching maturity and for percentage of flowers per head maturing achenes were added later.

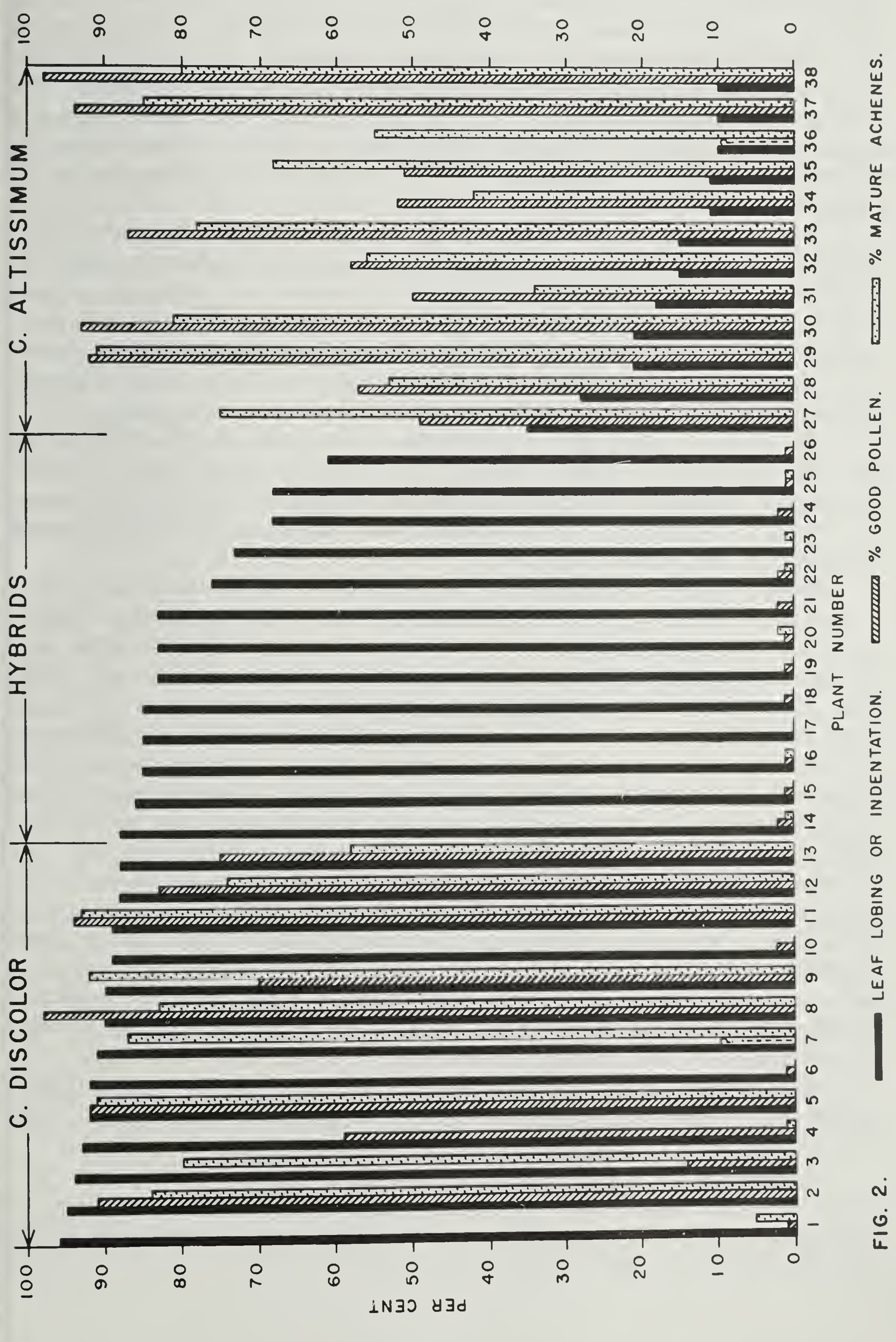
C. DISCOLOR
HYBRIDS
C. ALTISSIMUM
100
90
80
70
60
50
40
30
20
10
0
PER CENT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
PLANT NUMBER
▮ LEAF LOBING OR INDENTATION.
▨ % GOOD POLLEN.
▤ % MATURE ACHENES.

FIG. 2.

in the partial or complete sterility of first generation hybrids. The level of fertility of hybrids of later generations, when produced, is unpredictable. The gametic chromosome number, if different in the parental species, does not necessarily present an insurmountable barrier to the production of interspecific hybrids. Obviously, it may be of critical importance in the reproduction of the hybrids. The somatic chromosome number for C. *altissimum* has been reported on previous occasions to be 18 with rare exceptions when it is 20; that for C. *discolor* has been reported on several occasions to be 20 (Ownbey & Hsi, 1963).

A convenient way of determining the level of fertility of a suspected hybrid plant is to examine the pollen from mature anthers to see if it is normally formed. Abortion of seeds may also be a useful but not infallible indicator of hybridity. The assumption in either case is that the presence of unbalanced genomes in the hybrid inhibits or prevents the formation of viable gametes. Under such circumstances fertilization may be impossible or of rare occurrence.

As stated in the previous section, the data were arranged on the accompanying bar graph, Fig. 2, in order of descending percentage values for leaf lobing or indentation of the middle cauline leaves. To simplify reference to the individual plants depicted, they were numbered from left to right.

Referring to the graph, it is apparent that some plants, viz., 1, 4, 6, and 10, although falling definitely within the foliar type characteristic of C. *discolor,* almost without exception matured little pollen and few or no achenes. The sterility of these plants may have been spurious, i.e., attributable to extraneous factors, or at least their sterility was not demonstrably due to hybridity. Failure to produce good pollen could have been due to the advanced age of the plants associated with loss of vigor late in the growing season; or, in the absence of full anthers some which had already lost their normal pollen grains may inadvertently have been selected; or, the undisclosed effects of heavy fungal infestation sometimes prevalent in *Cirsium* may have been a contributing factor. Failure of achenes to mature may have been due to failure of pollination, failure of fertilization, or abortion due to unknown causes. Whatever the cause of partial or complete sterility, the four plants listed appeared upon inspection to be good C. *discolor* and in all respects fell within the normal range of leaf variation for fertile plants of C. *discolor.*

The remaining nine plants at the C. *discolor* end of the graph consistently exhibited a fairly high percentage of good pollen and achenes.

Moving to the other end of the graph, it is seen that plants 27-38 had dentate leaves and all exhibited a fairly high percentage of good pollen and achenes. These twelve plants were identified as C. *altissimum*.

Of special interest were plants 14-26, it must be emphasized, occupy their position on the graph strictly by virtue of the degree of lobing of the middle cauline leaves determined by completely objective methods. All of these plants produced less than 2% good pollen and seeds. It was, therefore, reasonable to assume that these thirteen plants were hybrids. Plant 14 had the same percentage value for leaf lobing as the adjacent plants of *C. discolor* and was indistinguishable on the basis of this single character. It appears probable that a narrow zone of overlap between the degree of lobing in *C. discolor* and that in the hybrids was present and that a small percentage of the hybrids must be identified by other means. No comparable overlap existed between the hybrids and *C. altissimum* among the plants examined.

If the above analysis is accepted as substantially correct, then some definitive observations may be made. Leaf lobing values (i.e., BC/AC, Fig. 1) for pure *C. discolor* vary from 88% to 96%. Lobing in the hybrids is more variable, with values ranging from 61% to 88%, and at the upper extreme intergrading with those for *C. discolor* over a narrow zone. Leaf indentation and lobing in *C. altissimum* is also quite variable, yielding values of 10% to 35%, and these values are separated by a pronounced gap from those of the hybrids.

The considerable variation in pollen and achene maturation exhibited in different plants of *C. altissimum* is best explained in terms of deficiencies in the samples themselves. Many extraneous factors may have affected the overall capacity of these plants to reproduce themselves at the end of the growing season. Genetically pure plants of either species collected at a more auspicious time might easily mature above 95% of their pollen grains and above 80% of their achenes. It is not thought, however, that the expectedly low pollen and seed maturation values, recorded in some plants of both species, are of any real significance.

Because of the high incidence of hybrids in Population Sample 2855, it can be assumed that cross-fertilization between *C. altissimum* and *C. discolor* is readily accomplished under special circumstances and that the first hybrid generation embryos are viable. It is probable that the highest incidence of interspecific hybridization occurs when one of the species is in great numerical preponderance. If such is the case and if the plants of the minority species could be shown to be to some extent self-incompatible, the potential for hybridization would be augmented. Incomplete tests of *C. altissimum* and *C. discolor* indicated that both are rather highly self-incompatible.

ANALYSIS OF PROGENIES OF SELECTED INDIVIDUALS

Progenies of several plants of Population Sample 2855 described above were started in the greenhouse and transplanted to the experimental garden in 1960. Most plants reached maturity the following summer. The garden-grown plants were subjected to the same form of analysis as the original population sample in all cases where there was a prospect of deriving useful comparative data. These data are summarized in Table 2.

Three offspring of parental plant 38, C. *altissimum*, were grown. All three individuals were determined to be pure C. *altissimum*, but one of them differed from the wild population in having the middle cauline leaves lobed nearly one-half the distance to the midrib.

Progenies of four C. *discolor* plants were grown, viz., plants 1, 3, 8, and 12. Plant 1 gave rise to two offspring, only one of which reached maturity. This individual, upon examination, proved to be a cross between C. *discolor* and C. *muticum*, not between C. *discolor* and C. *altissimum* as anticipated. Only 6% of its pollen was fully formed and only 7% of its achenes reached maturity. C. *discolor* × C. *muticum* hybrids are easily detected by the short spines of the involucral bracts, by the characteristic lobing of the leaves, by the intermediate density of the pubescence of the under surfaces of the leaves, and by the intermediate corolla color. Individuals of C. *muticum* were observed in the area where the original sample was obtained, in wetter ground at a distance of about 100 yards. The sterility of parental plant 1, referred to earlier, must, however, be attributed to factors other than casual and incomplete pollination by C. *muticum*.

The progeny of parental plant 3 consisted of thirteen individuals, only one of which deviated appreciably from C. *discolor* in leaf lobing. Examination of the pollen and achenes of this plant indicated that it was a hybrid, C. *discolor* × C. *altissimum*. The progeny of parental plant 8, consisting of five individuals, also appeared to be C. *discolor* with one exception in which the leaves were atypical. This plant, however, proved to be fully fertile and doubtless also was pure C. *discolor*. The progeny of parental plant 12 consisted of thirteen individuals, twelve of which were analyzed. All were determined to be pure C. *discolor*.

Progenies of two putative hybrid plants were grown, viz., plants 16 and 20. The single offspring of parental plant 16 had intermediate leaf indentation, was fully sterile, and was itself judged to be a hybrid. One of the two offspring of parental plant 20 had middle cauline leaves that fell within the normal range for C. *altissimum*. Upon examination, this plant was found to produce 6% good pollen and 7% fully formed achenes. It seems likely that this individual resulted from a backcross to C. *altissimum*. The other offspring of plant 20 was almost sterile and comparable in all respects to hybrid plants of the parental population.

Since all of the progenies discussed above were grown in a single bed, all were subjected to extensive cross-pollination by insects. C. *discolor* plants were in great preponderance, and one might expect that the achenes from the *C. altissimum* plants present would produce numerous hybrid plants of the first generation. This hypothesis was not tested. It is noteworthy, however, that parental plants of the wild population, generally speaking, produced offspring like themselves. Of thirty-three offspring of four *C. discolor* plants, only two were demonstrated to be hybrids, and only one of these represented the cross under study. The three offspring of a single *C. altissimum* plant were also *C. altissimum*. The three offspring of two hybrid plants were demonstrated to be hybrids, but one of them had the foliar characters of *C. altissimum*. The garden experiments, then, bear out the conclusions reached on the basis of the analysis of the wild population, i.e., *C. altissimum* and *C. discolor* do, in fact, hybridize but the hybrids are of very low fertility. Nevertheless, the potential for protracted hybridization between these species would appear to exist under special environmental conditions. If this is granted, then the evolution of intermediate forms more closely adapted for survival under the conditions provided by an agrarian human culture is conceivable.

SUMMARY

1. An analysis of thirty-eight individuals drawn from a wild population containing *Cirsium altissimum, C. discolor,* and their intermediates substantiates the hypothesis that the two species do, indeed, hybridize in nature.

2. Disturbance of the site was undoubtedly of primary importance in bringing the parental species into close proximity and in providing suitable habitats for the successful establishment of the hybrids.

3. All of the plants in Population Sample 2855 which had intermediate leaf types were determined to be hybrids. There did, however, appear to be a narrow zone of overlap between the leaves of *C. discolor* and an occasional hybrid; a similar overlap between *C. altissimum* and the hybrid was not observed.

4. More than 98% of the pollen and achenes of the hybrids were aborted before maturation.

5. The nearly complete sterility of some plants of *C. discolor* was not accounted for, but it was suggested that the unexpectedly low production of good pollen and mature achenes in the remaining plants of *C. discolor* and in *C. altissimum* was due to the lateness of the season, inadequacies of the samples, and other extraneous factors.

6. Progenies of selected individuals from the population sample were like their parents with two exceptions. The single offspring of one plant of *C. discolor* which reached maturity was a hybrid, *C. discolor* × *C. muticum*; one of several offspring of another plant of *C. discolor* was a hybrid, *C. discolor* × *C. altissimum*. The three offspring of two hybrid plants were also hybrids, but one individual appeared to be a backcross to *C. altissimum*.

7. The important role of self-incompatibility in promoting hybridization under special circumstances is indicated.

8. Hybridization may account for much of the intergradation between *C. altissimum* and *C. discolor* in other parts of their ranges.

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TABLE 1. Summary of Data for Population Sample 2855

Plant Number	No. of Lvs. Measured	Ave. % Indent. or Lobing	% Good Pollen	No. Heads Examined	Ave. % Fls. per Head Mat. Achenes
1	2	96	1	2	5
2	3	95	91	2	84
3	2	94	14	2	80
4	3	93	59	2	1
5	3	92	92	2	91
6	2	92	1-	2	0
7	3	91	undet.	2	87
8	2	90	98	2	83
9	2	90	70	2	92
10	2	89	2	2	0
11	2	89	94	2	93
12	2	88	83	2	74
13	3	88	76	2	58
14	3	88	2	2	1
15	3	86	1-	2	0
16	2	85	1-	2	1
17	2	85	0	2	0
18	2	85	1-	2	0
19	3	83	1	2	0
20	2	83	1-	2	2
21	2	83	2	2	0
22	3	76	2	2	1
23	3	73	0	2	1
24	2	68	2	2	0
25	4	68	1	2	1
26	3	61	1-	2	0
27	2	35	49	2	75
28	3	28	57	2	53
29	2	21	92	2	91
30	2	21	93	2	81
31	3	18	50	2	34
32	3	15	58	2	56
33	2	15	87	2	78
34	2	11	52	2	42
35	2	11	51	2	68
36	2	10	undet.	2	55
37	3	10	94	2	85
38	3	10	98	2	80

TABLE 2. Summary of Data for Open-pollinated Progenies of Selected Individuals of Population Sample 2855

Parental Plant	Progeny			
	% Leaf Lobing	% Good Pollen	% Mature Achenes	Identity
C. altissimum				
38	47	96	undet.	alt.
	31	94	62	"
	23	99	88	"
C. discolor				
1	undet.	6	7	disc. x mut.
3	86	0	0	disc. x alt.
8	88	98	75	disc.
12	95	97	89	"
"	94	99	84	"
"	93	99	82	"
"	93	98	ca. 90	"
"	92	99	ca. 90	"
"	92	99	86	"
"	92	99	78	"
"	92	97	87	"
"	91	99	80	"
"	91	98	undet.	"
"	90	99	undet.	"
"	89	undet.	68	"
Hybrids				
16	74	0	0	alt. x disc.
20	77	1-	1-	"
"	31	6	7	"

SKUNK-CABBAGE IN MICHIGAN

Edward G. Voss
Herbarium, The University of Michigan, Ann Arbor

Although it is realized by most people that all kinds of plants do not grow in all places on the earth, lack of knowledge about the details of distribution of any given species often leads us to take for granted as widespread those with which we happen to be familiar. So it is with skunk-cabbage, *Symplocarpus foetidus* (L.) Nutt., southward in the Great Lakes region.

This species, no less loved as a harbinger of spring for its odor at flowering time, which one writer uncharitably said "combines the skunk, putrid meat and garlic," is well known in southern Michigan, where it is abundant in low woods and ravines. On the other hand, the Northwestern Chapter of the Michigan Botanical Club makes a special spring field trip to see skunk-cabbage in the Traverse City area.

The accompanying distribution map (Fig. 1) will be misleading without some supplementary comments. Northward to 43° latitude, or a little farther (Muskegon, Grand Rapids, Midland, and Port Huron), skunk-cabbage is common. Its absence from several of the southern counties on the map is surely due to lack of collecting. Plants of this species are somewhat more difficult to collect and press into neat specimens than most wildflowers; this fact, and a probable assumption that it is so common as hardly to warrant collecting, must account for the general paucity of specimens in herbaria.

Farther north in the state, however, skunk-cabbage becomes much more scarce and local. The northern dots on the map represent for the most part specimens from local colonies, which collectors in recent years have realized to be geographically significant.[1] In short, the dots on the map greatly under-represent the comparative abundance and frequency of this species in the southern third of the Lower Peninsula. A similar distribution pattern in southern Ontario has been presented by Soper and Rao (1958) and in Wisconsin by Fassett (1937), who stated: "the apparent rarity in the northern part of the state may be due to lack of collecting in that region in the early spring." We know that in northern Michigan the rarity is genuine, and Prof. Hugh Iltis of the University of Wisconsin informs me that the species *is* more or less rare in northern Wisconsin. (The apparent abundance there in Lincoln Co. is due to the assiduous collecting of Frank C. Seymour, who merely lists the species as "occasional.")

Such isolated occurrences as we have northward may represent relics of a once more continuous distribution, rather than chance dispersal by the agency of man or other animals. We need more data on distribution and the factors which affect it before working out a definitive correlation with postglacial climatic and vegetational history. However, it is worth calling attention to two factors which may be related: First, the tempering influence of island climates seems to favor the growth of skunk-cabbage, for the only two places in the northern part of the state where I have seen it to be common and widespread, and from which it has been known for many years, are on Beaver Island, in the north end of Lake Michigan, and on Isle Royale, in northwest Lake Superior. Specimens also exist from

---

[1] The 11 northernmost collections on the mainland of the Upper and Lower Peninsulas, shown on the map by solid circles, all represent collections made during the years 1953-1961, as do the open circles in Houghton and Baraga counties, for specimens not yet seen by me.

Michipicoten and South Lizard Islands in eastern Lake Superior (Ontario). Secondly, we must consider the sturdy underground growth of this species, giving it a reputation for longevity as "a Methuselah of the plant world" (Shull, 1924).

As is known to anyone who has attempted to dig up a plant of skunk-cabbage, there is a stout underground "trunk," perhaps two feet or more in length; each year new roots reaching down from the crown become anchored and, it is said, by contractile action pull the plant into the soil, compensating for the growth which would otherwise result in an erect above-ground stem. The large colonies of

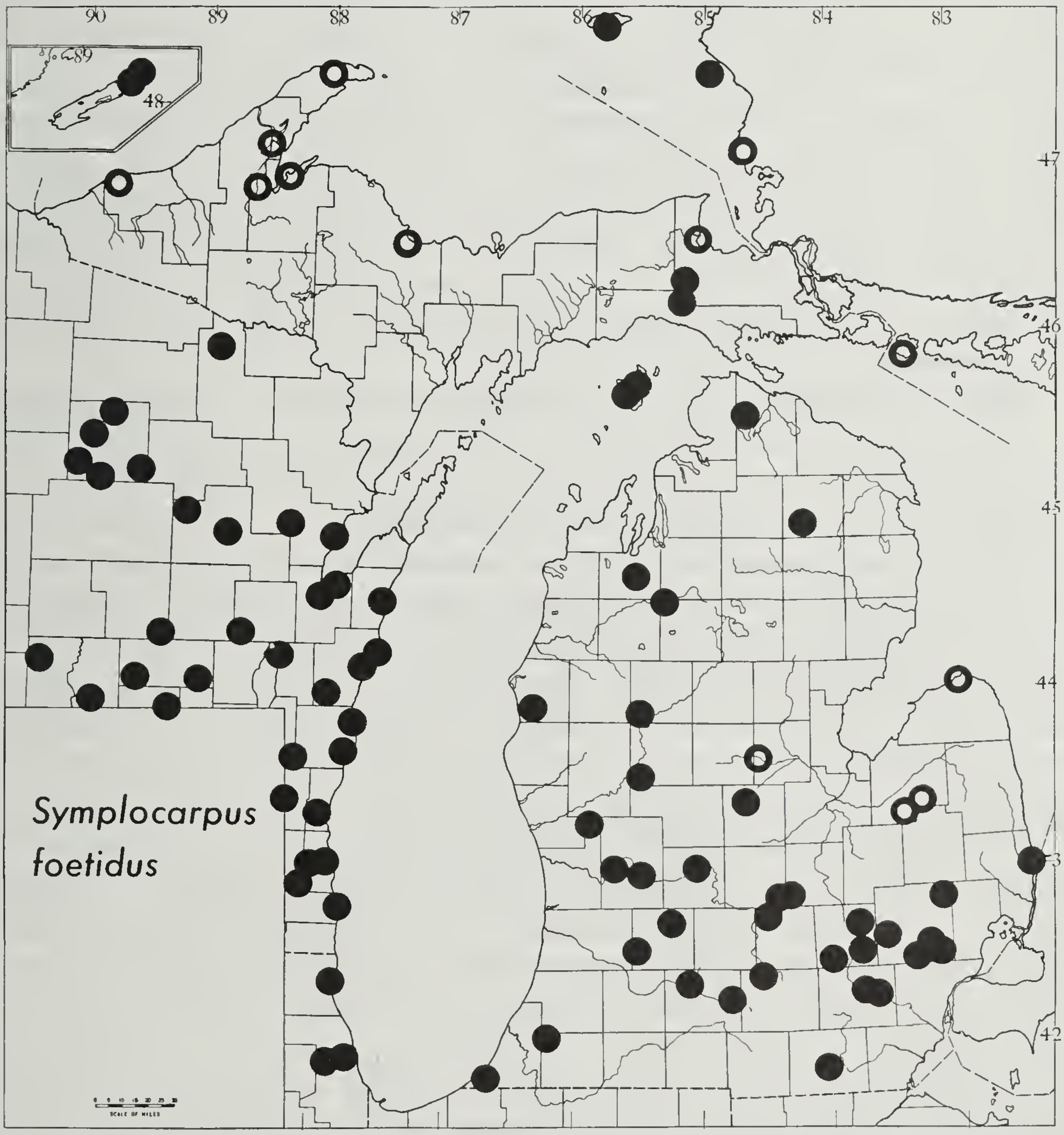

Fig. 1. Distribution of *Symplocarpus foetidus* in Michigan and adjacent areas. Wisconsin records from Fassett (1937), supplemented by data kindly supplied by Hugh H. Iltis. Elsewhere, solid circles represent specimens examined in the following herbaria: The University of Michigan, Michigan State University, Cranbrook Institute of Science, Wayne State University, Albion College, Alma College, Aquinas College, Isle Royale National Park, and University of Michigan Biological Station; open circles represent northern records for which specimens have not been seen—see text for discussion.

this species in favorable sites attest to the powers of vegetative spread by means of rhizomes. And each "new" plant becomes more firmly buried each year by the peculiar action of the roots. So Shull suggests that "the Skunk Cabbage that is seen today growing in unpretentiousness in any bog may possibly outrival the sturdiest of the oaks in point of age, may not improbably have occupied that very spot long years before Columbus set foot upon our shores and may continue there a thousand years and more from now if only the fates be kind." Is it possible that the local colonies of *Symplocarpus* northward represent ancient plants persisting in particularly favorable niches?

Not only is the local distribution of *Symplocarpus foetidus* of interest, but it is also illustrative of a world distribution which has long fascinated plant geographers. The same species (the only one in this genus) occurs in northeastern Asia. Other familiar genera of eastern North America with the same or closely related species in eastern Asia include *Onoclea* (sensitive fern), *Podophyllum* (Mayapple), *Caulophyllum* (blue-cohosh), *Jeffersonia* (twinleaf), *Menispermum* (moonseed), and *Phryma* (lopseed). (See Li, 1952, for a longer list and discussion.)

The northernmost and westernmost station for skunk-cabbage in North America is apparently from Winnipegosis, in western Manitoba (Scoggan, 1957, p. 194). There has been considerable study of the life history of the species; a useful bibliography is included in Wilson (1960). Its distribution in Ontario is discussed by Soper and Rao (1958), to whose data the present notes constitute a western supplement.

The occurrence of skunk-cabbage is too often taken for granted by collectors. (For example, there are no collections in Michigan herbaria from Wayne County, despite the abundance of collectors in the Detroit region.) We need good herbarium specimens from areas not represented on the map by solid circles. The open circles will give some idea of potential localities in which to seek substantiating specimens; even more interesting will be specimens from "unknown" territory. Collections made early in the season should if possible include young leaves and inflorescence attached to a portion of rhizome. The rhizome and inflorescence (a densely flowered spadix, as in other members of the arum or calla family) should be split lengthwise to reduce bulk and hasten drying. Mild heat during drying and circulation of air through the plant press will help to speed the process and to avert mold. Later in the season, some fruit in addition to leaves would be of interest; fruiting specimens are nearly nonexistent in herbaria. Make each specimen as flat as possible, neatly arranged to occupy a space not exceeding 11 × 16 inches, and include full data on locality, habitat, and date on a label.

The open circles on the map represent published or other reports for which I have not seen specimens, as follows:

ONTARIO: "Cedar bog, Pancake river" (Taylor, 1938, p. 92; mapped by Soper & Rao, 1958). Cockburn Island in 1959 (J.H.Soper, personal communication).

MICHIGAN: KEWEENAW CO.: specimen from Delaware in Gray Herbarium, acc. to W. G. Dore (personal communication).

ONTONAGON CO.: Porcupine Mountains, alder thicket on floodplain of Carp Creek (Ruthven, 1906, cf. pp. 79, 33, 22; apparently no specimens made).

HOUGHTON CO.: Sturgeon River "delta" north of U.S. 41 and elsewhere in vicinity of Chassell. (Specimen in herbarium of Ford Forestry Center, L'Anse, acc. to Eric A. Bourdo, personal communication.)

BARAGA CO.: near Pequaming, and also in black spruce swamp about three miles east of Houghton Co. (Specimens in herbarium of Ford Forestry Center, acc. to Eric A. Bourdo, personal communication.)

MARQUETTE CO.: locally common along highway M-28 just east of Marquette, acc. to W. J. Merry (personal communication).

CHIPPEWA CO.: "Wet ground near Emerson. Apparently rare." (Dodge, 1921, p. 141. No specimens.)

MIDLAND CO.: Chippewa River bank, Greendale Tp. (R. R. Dreisbach, notes in University of Michigan Herbarium.)

HURON CO.: "On moist ground near Port Austin. Infrequent." (Dodge, 1911, p. 84. No specimens.)

TUSCOLA CO.: "Common in swampy woods, Dayton Tp." (Davis, 1909, p. 342. No specimens.) "Abundant in shaded ground along and on the banks of a small creek near Murphy's Lake." (Dodge, 1921, p. 180. No specimens.)

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MICHIGAN PLANTS IN PRINT

New Literature Relating to Michigan Botany

The aim of this section is to list all significant literature relating to Michigan botany published since the beginning of 1960, without attempting much coverage of related fields such as agriculture, conservation, and forestry. When the subject matter or relation to Michigan is not clear from the title, annotations are added in brackets.

B. BOOKS, BULLETINS, SPECIAL REPORTS, AND MISCELLANEOUS

Benzie, John W. 1963. Cutting Methods in Mixed Conifer Swamps, Upper Michigan. Lake States Forest Exp. Sta., U.S. Forest Serv. Res. Pap. LS-4. 24 pp. [Includes general ecological information on conifer swamps in four locations.]

Gillett, John M. 1963. The Gentians of Canada Alaska and Greenland. Canad. Dep. Agr. Publ. 1180. 99 pp. [Distribution maps for many of the Gentianaceae & Menyanthaceae include dots in Michigan, although relatively little Michigan material was examined. Clothbound, illustrated, $2.50 from Queen's Printer, Ottawa.]

Harding, Walter (ed.). 1962. Thoreau's Minnesota Journey: Two Documents. Thoreau Soc. Bookl. 16. Geneseo, N.Y. 60 pp. [Includes annotated transcript of Thoreau's manuscript "Notes on the Journey West," an account of a trip in 1861 which mentions a great many plants noted. Michigan observations may be found for May 21 (Detroit to Chicago), June 29 (Carp River, Leelanau Co.), June 30-July 4 (Mackinac Island and vicinity); Appendix IX is a list of plants seen at Mackinac Island. Altogether a rather interesting early account of the flora of Minnesota and northern Michigan. Thoreau's abominable penmanship caused some difficulties for the non-botanical editor, so that, e.g., we have "Irexvilla" and "thalix" for (presumably) Diervilla and Salix.]

Janke, Robert A. 1962. The Wildflowers of Isle Royale National Park. Wolf's Eye, vol. 5, nos. 2-3. 85 pp. [Pocket-size booklet with brief descriptions and sketches of 101 plants. $1.00 (see p. 103).]

Johnsson, Robert G. 1963. The Orchids of Isle Royale National Park. Wolf's Eye, vol. 6, no. 2. 29 pp. [Key and descriptions for 34 species, three of which almost certainly do not occur on Isle Royale in spite of earlier reports to the contrary: *Habenaria leucophaea* (based on a misidentified Foote collection of *H. psycodes*); *Goodyera pubescens* (based on a misidientified Brown collection of *G. tessellata*); and *Liparis liliifolia* (no specimens, and surely not to be expected so far north). $.50 (see p. 103)]

Linn, Robert M. 1962. Forests and Trees of Isle Royale National Park. Wolf's Eye, vol. 6, No. 1. 34 pp. [Ecological background and key to woody plants. $.50 (see p. 103)]

Rudolf, Paul O., & R. L. Schoenike. 1963. Botanical and Commercial Range of Jack Pine in the Lake States. Lake States Forest Exp. Sta., U.S. Forest Serv. Res. Note LS-15. 4 pp. [Includes detailed distribution map for Michigan, Wisconsin, & Minnesota; dot on North Manitou Island probably belongs on South Manitou. Map of commercial range showing 1,000 to 99,999 cords per acre on the Manitous and Beaver Isl. is misleading, for jack pine is known only from S. Manitou among these islands.]

Smith, Alexander H. 1963. The Mushroom Hunter's Field Guide Revised and Enlarged. Univ. Mich. Press, Ann Arbor. 264 pp. + section of color illustrations. [Review here of this popular and handsomely illustrated work is unnecessary. General reference to occurrence in Michigan is made under several of the species. $6.95]

Editorial Notes

We are grateful to several authors (or their institutions) for the provision of funds for extra pages in this issue. Without such aid, it would not be possible to publish as large issues as we are having.

Separate reprints (with covers) of the entire article by Howard Crum on mosses of the Douglas Lake region (from the January and March numbers) will be available for $.40 each, postpaid, from the U.M.B.S. Store, Pellston, Michigan 49769.

Readers who have suitable black and white photographs are encouraged to submit good prints for consideration as cover pictures for THE MICHIGAN BOTANIST.

Dates of mailing:

The January number (Vol. III, No. 1) was mailed January 29, 1964.
The March number (Vol. III, No. 2) was mailed March 5, 1964.

COUNTY MAP INFORMATION

The new map book for the northern portion of the Lower Peninsula (Region 2) is expected by the Michigan Department of Conservation to be ready in mid-summer. Individual new maps for the following counties in this region are, however, now available: Alcona, Alpena, Arenac, Antrim, Benzie, Charlevoix, Cheboygan, Crawford, Emmet, Gladwin, Grand Traverse, Iosco, Kalkaska, Leelanau, Manistee, Mason, Missaukee, Montmorency, Ogemaw, Osceola, Oscoda, Otsego, Presque Isle, Roscommon, and Wexford.

A single map sheet for any of these counties is free; all sheets in excess of one are $.10 each. The same rate applies to individual map sheets for regions 1 and 3. The entire books for region 1 (Upper Peninsula) and region 3 (southern Lower Peninsula) are $1.00 each. All requests should be accompanied by check or money order for correct amount of purchase, plus 4% Michigan State Sales Tax. Mail to Michigan Department of Conservation, Maps and Publications, Lansing, Michigan 48926.

Botanists contemplating field work in Michigan this season will find these outstanding maps invaluable.

ISLE ROYALE NATURAL HISTORY ASSOCIATION

The new Park Naturalist at Isle Royale, William W. Dunmire, is continuing to work with the Isle Royale Natural History Association, so ably given life by his predecessor, Dr. Robert Linn, who was promoted a year ago to a Washington job in charge of research for the National Park Service. Annual dues are $2.00, and members receive various interesting publications, including issues of ''Wolf's Eye'' and (most recently) a popular map of Isle Royale. (The latter will sell for $1.00 at the Park this summer.)

Special botanical issues of ''Wolf's Eye'' by Janke, Johnsson, and Linn are cited, with prices, in the New Literature list in this number of THE MICHIGAN BOTANIST. $.10 per publication should be added for mail orders for past publications; orders, and/or dues for 1964, may be sent to Isle Royale Natural History Association, Isle Royale National Park, Houghton, Michigan 49931.

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(On the cover: Skunk-cabbage, Symplocarpus foetidus, photographed in March, 1961, by Douglas J. Fulton, in the Nichols Arboretum, University of Michigan, Ann Arbor. See page 97.)

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Articles and notes relating to any phase of botany in the Upper Great Lakes region are welcomed; manuscripts should be sent to the editor in chief. Subscriptions and inquiries regarding them (from those not members of the Michigan Botanical Club) should be sent to the circulation manager, who will assume that subscriptions received prior to the last number of a volume are intended to begin with the first number of that volume unless specified to the contrary.

Manuscripts intended for publication should be neatly typed, double-spaced, carefully prepared and checked for accuracy before submission, as our method of printing does not include a proof which can be sent to authors. Follow the style of recent issues, especially in regard to references. In determining suitability of material for publication, the editors and reviewers must consider the wide diversity of botanical interests among our members and subscribers and seek appropriate clarity and precision. Authors of more than two pages of print in an issue will receive, if requested in advance, five copies of that issue. Reprints may be ordered at cost.

THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora and to establish suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Inquiries regarding membership may be directed to the state secretary or, from those residing where there is a chapter, to the appropriate chapter secretary. (The Southeastern Chapter is centered in the Detroit metropolitan area; the Huron Valley Chapter, in Washtenaw County; and the Northwestern Chapter, in the northwestern Lower Peninsula.) Dues are modest, but vary slightly among the chapters; in all cases, they include subscription to THE MICHIGAN BOTANIST.

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SEEDS AND SEEDLINGS OF NATIVE ORCHIDS

Warren P. Stoutamire
Cranbrook Institute of Science, Bloomfield Hills

The region of the north-central United States and Canada dominated by Lakes Huron, Michigan, and Superior contains a notably rich orchid flora. Over fifty species of orchids occur in this region and they are of interest for a number of reasons, one of which is their unusual seedling development. The small seeds germinate and grow much more slowly than those of more familiar plants, and their rather specialized requirements make their survival precarious. This leads to questions of the survival of orchid populations both in natural conditions and in changed conditions imposed by man. A better understanding of the seedling, the most vulnerable stage of the orchid life cycle, could lead to more intelligent conservation practices, at least as far as this family is concerned.

The orchid family (Orchidaceae) is one of the largest families of flowering plants. It is best represented in tropical and subtropical regions, but some species extend well into sub-arctic areas. Nearly 200 species (Correll, 1950) occur within the United States and over 25% of these occur in the region of the three western Great Lakes. The region has two-thirds of the approximately 75 species listed by Fernald (1950) for the central and northeastern United States and adjacent Canada. Tropical and subtropical orchid species are frequently adapted to growing on trunks or limbs of trees, and these are called epiphytes. These are not parasites in the usual sense, but merely use the tree for physical support. All of our north-temperate orchid species are by contrast terrestrial, rooted in the ground, and their methods of nutrition consequently differ from those of epiphytes.

Orchid species have a reputation for requiring long periods of growth between seed germination and the first flowering. Many species are slow growing and 4 or more years may elapse before flowering occurs, but this is by no means universally true. Plants of the tropical *Oncidium pusillum* have recently been reported to flower 2 years after seed germination by Livingston (1962). Segars (1963) claimed that a hybrid swan orchid *Cycnoches* flowered 15 months after seed germination. Two-year-old seedlings of our native *Spiranthes cernua*, the Nodding Lady's Tresses, growing in *Sphagnum*, have leaf rosettes 4 cm in diameter, approximately that of blooming size plants. In contrast to these relatively short periods, Curtis (1943) found that some plants of *Cypripedium acaule*, the Pink or Stemless Lady's Slipper, did not flower until 8-12 years after germination and Summerhayes (1951) suggests that some orchid species can persist indefinitely in the pre-flowering stages if growing conditions are not optimum. Environmental conditions of course influence both the speed of development and the subsequent flowering of orchid plants. Some European *Orchis* species (two species of this genus are native to the Great Lakes region) have been suggested to have a monocarpic tendency (plants which flower once and then die) by Salisbury (1942). Tamm (1948) has questioned this, but some of our native orchid species are known to flower either irregularly or to flower strongly one year and then produce a reduced inflorescence in the following year (Case, 1962).

THE ORCHID SEED

Orchid seeds are among the smallest produced by flowering plants. They rarely are longer than 2 mm and may be as small as 0.3 mm. The orchid seed consists of an outer, usually transparent seed coat and a small round or oval mass of cells comprising the embryo. This embryo may consist of a very small number of cells (Leavett illustrated an embryo with 10 cells in 1901) and is similar in its reduction to the 9-celled embryos which occur in *Monotropa hypopithys*, Pinesap, described by Francke (1935). The orchid seed lacks endosperm, which is the food storage tissue in many seeds, and very little stored food is present in the reduced embryo itself. Ripened seed capsules usually contain large numbers of seeds, however. One tropical species has been estimated to produce 3.7 million seeds per capsule (Withner, 1959) and a capsule of our native *Cypripedium acaule* from Oakland County, Michigan, contained 103 milligrams of seeds, with a count of 526 seeds/mg. This gives approximately 54,180 seeds produced by one flower. Not all species produce in this quantity. A capsule of *Malaxis monophyllos* (Adder's-mouth) from Oakland County contained only 1,572 seeds in a 3.5-mm-long capsule. Plants averaged 12.4 capsules, giving approximately 19,490 seeds per year. A *Listera cordata* (Heart-leaved Twayblade) capsule from the Sibley Peninsula of Canada contained 376 seeds, and the average of 7.6 capsules per plant gives 2,860 seeds per year.

Seeds of our native species differ in their rate of development within the capsule and in the time of their release. *Listera cordata* seeds are sometimes released from the lower capsules of a stalk while the upper flowers are still open and apparently functional. Mr. and Mrs. Case have observed seeds being released from fruits whose flower parts were still apparently functional. This species is one of the earliest to flower in the Great Lakes area and its seeds are released earlier than those of any other. *Spiranthes cernua* also ripens and releases its seeds very soon after flowering, but the timing in this case is correlated with the necessity for quick ripening because of its autumn blooming habit. Many populations of *Spiranthes cernua* produce seeds without the necessity of pollination or fertilization. This asexual production of seeds is called apomixis, and the condition is known to occur in many plants. Small groups of cells are produced from an inner seed coat (Leavitt, 1900; Swamy, 1949) and these form the embryo of the seed. An indefinite number of these asexually produced embryos are produced in each seed, and can easily be seen within the transparent seed coat with the aid of a low power microscope. This multiple embryo condition is referred to as polyembryony. Polyembryonic seeds have also been reported in species of *Cypripedium* (Lady's-slippers), *Corallorhiza* (Coral-roots), *Habenaria* (Rein-orchids), and in *Goodyera* (Rattlesnake Plantains) by Leavitt (1901).

The majority of temperate zone orchids begin to release their seeds from ripened capsules in September and October. Seeds are sifted out slowly as the capsules are shaken by the wind, and some species continue to release seeds through the winter if the capsules are held above the snow. I have collected numerous mature but unopened capsules of *Cypripedium arietinum* (Ram's-head Lady's-slipper) the spring following flowering. These were normal, undamaged fruits with large quantities of seeds. One wonders how viable temperate orchid seeds are under extreme temperature conditions. I have seen capsules of *Cypripedium calceolus* (Yellow Lady's-slipper) exposed above the snow cover in January, still containing quantities of seeds, and exposed repeatedly to near zero temperatures. The proper way to test viability would be to germinate these seeds, but unfortunately those of *Cypripedium* species are among the most difficult of all our species to germinate under experimental conditions.

No adequate studies have been made of the seed viability of orchid species. Curtis (1943) said that *Cypripedium* seeds remained viable after 8 years of storage, and I have germinated seeds of *Calopogon pulchellus* (Grass Pink) which were stored in a refrigerated dessicator for 5 years. Since most of our species release their seeds in autumn, the first visible stages of growth probably do not occur until the following spring or summer, but here again there has been little observation as to what actually happens in nature.

THE ORCHID SEEDLING

Orchid embryos are extremely reduced in comparison with those of most other plants, and their early germination stages are consequently different. Embryos of all species enlarge to produce an oval or egg-shaped mass of cells called a protocorm, and this is frequently covered with absorbing hairs called rhizoids. Protocorms of some terrestrial species develop chlorophyll as the embryo swells and begins growth, and these photosynthetic protocorms develop comparatively rapidly. Some species may not develop chlorophyll for months or years after growth has commenced. These are much slower in growth because the plant cannot make its own food materials but must get them from other sources.

The "other sources" are usually fungi which grow into cells of the developing protocorm, and invade the entire root system of older plants. The orchid tissues destroy the invading hyphae (individual strands of the fungus) and absorb the materials which the fungus has brought in. The close association of the fungus with orchid roots produces structures called mycorrhizae, which are made up of both orchid and fungal tissues. More familiar examples of two dissimilar plants growing together but in this case forming a new kind of organism, are the lichens, composed of algae and fungi. The mycorrhizal fungi from orchid root systems have been repeatedly isolated and identified. Many of them are species of *Rhizoctonia. Rhizoctonia solani* has been isolated from orchid roots (Downie, 1959). Many genetic strains of this fungus exist, and some of them are responsible for important diseases of crops, including potatoes. Repeated experiments have been made to determine whether individual orchid species form mycorrhizal associations with specific fungi, and the results have shown that the association is non-specific (Curtis, 1937, 1939; Downie, 1959). More than one fungus can be isolated from an orchid species and more than one fungus can be recombined with seedlings of a single species. The over-wintering corms of some terrestrial orchids are essentially free of fungal hyphae, a fact which led Bernard (1911) to suggest a compound in these organs which prevents infection. Recent work reviewed by Braun (1963) has confirmed this. It has been found that fungi secrete substances which stimulate the orchid corm to produce the compound orchinol which inhibits fungal growth. In our native genera which produce corms *(Calopogon, Liparis, Arethusa, Malaxis)* the root system dies at the end of each growing season, and is replaced by new roots the following year. This necessitates new fungal infection of the roots each year.

Although the fungi which are most frequently isolated from orchid root systems are species of the genus *Rhizoctonia,* prominent exceptions are the fungi which occur in *Corallorhiza* (Coral-root) species in Scotland (Downie, 1943), Germany (Burgeff, 1936), and in the United States. These bear prominent clamp connections and are Basidiomycetes. The Basidiomycetes which have been observed in *Corallorhiza* are difficult to grow on synthetic media.

What do we know about orchid seedlings in nature? Several workers have searched for and found early stages of growth in Europe and North America (Fabre, 1853; Fuchs and Ziegenspeck, 1926; Montford and Küsters, 1941; Curtis, 1943). Seedlings have been most frequently found near the root systems of mature plants, where they sometimes occur in large numbers. Mortality is extremely high in the first years of growth, however, and very few of the seedlings ever reach flowering stages. Most of the seedlings which have been examined are of species which spend one to several years growing underground, being supported by the fungi which surround and penetrate them. Curtis (1943) found that *Cypripedium acaule* did not produce a green above-ground leaf until its third year of growth. Flowering did not begin until 8-12 years after germination. *Cypripedium reginae* (Showy Lady's-slipper) also required three seasons of below-ground growth before the first leaf was produced. Waterman (1949) planted seeds of this species in a wet area and above-ground shoots appeared only two years later. Five years after planting the shoots were only 15 cm tall. Summerhayes (1951) even suggests that some mature orchid plants can revert to the subterranean type of growth under severe environmental conditions and persist for years until conditions improve. Subterranean growth is not unusual in orchids; our *Corallorhiza* species grow almost entirely underground, except for their flowering stalks. Two species of Australian orchids carry this to the ultimate degree; they flower underground as well (Erickson, 1951).

The early stages of orchid growth are difficult to find because of the very small size of the seedlings. In order to learn more about the early growth of these plants several people have used the aseptic growth methods which work so well for tropical orchid species. Terrestrial orchids have been grown under controlled conditions in Europe, but the subject has been largely untouched in North America. Burgeff (1954), in a long series of experiments, succeeded in germinating the seeds of both terrestrial European and exotic species and growing them to flowering. He found that keeping the fungus and orchid growth in proper balance after inoculation with fungus was a critical step. He devised special potting methods to insure proper growth of both partners. Vermeulen (1947), in his work with *Orchis* and *Dactylorchis* species in Holland, was also successful in growing plants to the flowering stage. In this country Liddell (1944) successfully germinated *Calopogon pulchellus* (Grass Pink), but the plants were apparently not carried beyond the seedling stage. Withner (1953) was able to produce protocorms of *Cypripedium acaule* in sterile culture, but only if he removed immature seeds from green capsules. If the seeds were allowed to ripen, they could not be germinated. Curtis (1943) produced early seedling stages of *Cypripedium acaule* and *Cypripedium reginae* on sterile media by limiting the amount of O_2 which reached the seeds. His statement that many native species have been successfully raised from seed is not supported in the literature.

METHODS

I have used the sterile growth methods of these workers for several years, modifying them frequently, and discarding methods which do not work for me. I have had limited success, and the remainder of this paper is a report on some of the orchid species of the Great Lakes region which can be germinated on synthetic media. Seeds for this work have been collected by myself, and by Mr. and Mrs. Frederick W. Case, Jr., Mr. and Mrs. Dale J. Hagenah, and by Mr. Paul W. Thompson. All seed samples were sterilized by shaking them for 20 minutes in a 7.5% solution of calcium hypochlorite, washed twice in sterile distilled water, and sowed on one of several sucrose-mineral-agar mixtures. Knudson C and Burgeff's N_3f (listed in Withner, 1959) have been most frequently used. With so many unknown factors involved as well as limited amounts of both seed and time, it has not yet been possible to run parallel cultures on several media. I have therefore concentrated on a modified Knudson C medium changed to contain 8 g. agar/1, with versene added to the initial $FeSO_4$ solution, and 2 g. of peptone added per liter. Culture bottles have been kept in north-facing windows and under fluorescent lights at room temperatures at Cranbrook Institute of Science, and in controlled temperature rooms (20°C) at the University of Michigan. Native species have tended to germinate and grow best under natural light in windows and under timed lights (12 hours light, 12 dark) in the 20°C rooms. Continuous light is inhibitory in some cases. Growing plants are transferred to fresh media at 6-12 month intervals, or when crowding requires it.

THE RESULTS

Great Lakes species can conveniently be divided into three groups on the basis of their germination behavior: those which do not germinate under these conditions, those which grow without chlorophyll, and those which develop chlorophyll as growth begins. They will be discussed in this order.

The first group includes those species which so far have not been germinated on experimental media. All five of the nature *Cypripedium* species belong here. Prolonged refrigeration of cultures, limiting O_2, and other manipulations of the culture medium have failed to initiate germination despite repeated trials. Withner's technique of culturing embryos removed from capsules 6 weeks after pollination does work, to a point. These immature seeds have produced 2-5 mm long protocorms, which have subsequently ceased growth (Figs. 1 and 2). A type of dormancy develops in ripe seeds which we do not yet know how to break. The dormancy obviously is overcome in nature. Other orchids which I have been unable to germinate are:

Aplectrum hyemale	Putty-root
Arethusa bulbosa	Arethusa
Calypso bulbosa	Calypso
Corallorhiza maculata	Spotted Coral-root
Corallorhiza odontorhiza	Autumn Coral-root
Corallorhiza striata	Striped Coral-root
Corallorhiza trifida	Early Coral-root
Epipactis helleborine	Helleborine
Goodyera repens	Lesser Rattlesnake Plantain
Habenaria clavellata	Club-spur Orchid
Habenaria flava	Southern Rein-orchid
Habenaria hyperborea	Northern Green Orchid
Habenaria lacera	Ragged Fringed Orchid
Habenaria leucophaea	Prairie White-fringed Orchid

Habenaria obtusata	One-leafed Rein-orchid
Habenaria psycodes	Purple-fringed Orchid
Isotria verticillata	Whorled Pogonia
Liparis lilifolia	Large Twayblade
Malaxis monophyllos	White Adder's-mouth
Orchis spectabilis	Showy Orchid

The lack of results may be due to any of several causes. It is possible that some species lose their ability to germinate after even a few days of storage. This could be checked for each species if freshly dehisced capsules were available for immediate sowing. Some species may be sensitive to the calcium hypochlorite sterilizing solution, although the large commercial orchid industry uses it without noticeably harmful results. These non-germinating species may require specific growth substances which are not in the synthetic medium, or they may require a cold treatment for germination. Research currently under way with refrigerated seeds does not support this, however. Seedlings may have narrow pH tolerances, a not improbable situation, since some of our local species seem to grow within well circumscribed pH ranges. The seeds of some species may receive stimulation to germinate from mycorrhizal fungi. Any of these could be significant.

A second group of orchid species produces very slow-growing protocorms lacking chlorophyll, at least for the 2-3 year period the cultures have been maintained here. *Liparis loeselii* (Loesel's Twayblade) has formed dark brown, 1 cm long structures bearing rhizoids and scale-like leaves in three years of growth (Fig. 7). I do not know whether these resemble *Liparis* seedlings in nature, since neither I nor anyone else has reported finding them. These dark, almost formless structures would be very difficult to spot under native conditions. Seeds of the *Goodyera* species (Rattlesnake Plantains) produce slow growing, white to cream colored protocorms which develop rhizoids and then scale-like leaves after several months of growth (Figs. 5, 6, 8). Some of these are now 4 years old, but only 3-4 mm long. Downie (1940, 1943) germinated seed of *G. repens* (Lesser Rattlesnake Plantain) when mycorrhizal fungi were added to the sterile seeds in water. *Goodyera* species are plants of moderately to deeply shaded, well drained situations and photosynthetic protocorms would be of less value to them than to orchids of bright situations. The initially colorless protocorms which develop in the laboratory are probably a normal state of affairs. Ames has described the early seedling stages as they occur in nature (illustrations in Correll, 1950). There seems to be little significant difference between seedlings of *Goodyera pubescens* (Downy Rattlesnake Plantain), hybrid seedlings of *G. pubescens* × *repens*, or *G. oblongifolia* (Menzie's Rattlesnake Plantain).

Listera cordata (Heart-leaved Twayblade) seeds germinate very poorly under my conditions, and after 15 months growth the protocorms are undifferentiated, colorless masses of cells approximately 1 mm long (Fig. 4). *Habenaria hookeri* (Hooker's Rein-orchid) produced 1 mm colorless cell masses after 24 months, and these have ceased growth (Fig. 3). This species, occurring in shady, well drained situations, is very different in its seedling development from its relatives of brighter and wetter situations, to be described later.

Soon after growth begins, the protocorm cells of most terrestrial species develop a granular appearance, caused by an accumulation of starch grains within the cells. The contents of crushed protocorms stain dark blue-black with iodine, a standard test for starch. The only source for this stored carbohydrate in non-photosynthetic protocorms is the sucrose originally added to the culture bottles.

The last, and in many ways the most interesting, group of Great Lakes orchid species includes those which produce green protocorms before extensive seedling development has occurred. This group includes species of the genera *Calopogon*, *Habenaria*, *Pogonia*, and *Spiranthes*. Species differ in their rate of development and in the form of their seedlings, but they all have a common denominator: they are characteristic species of wet, open or partially shaded locations.

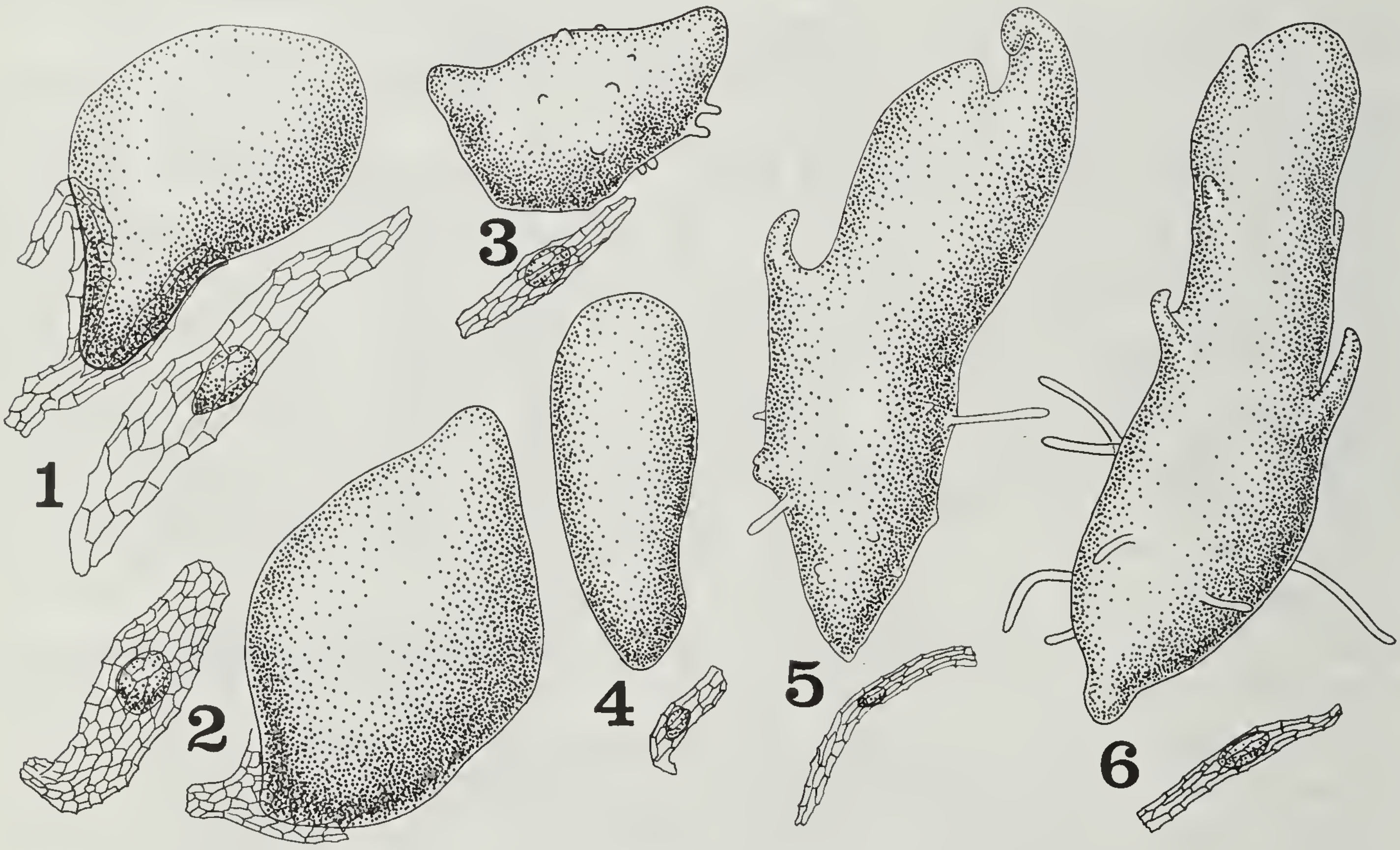


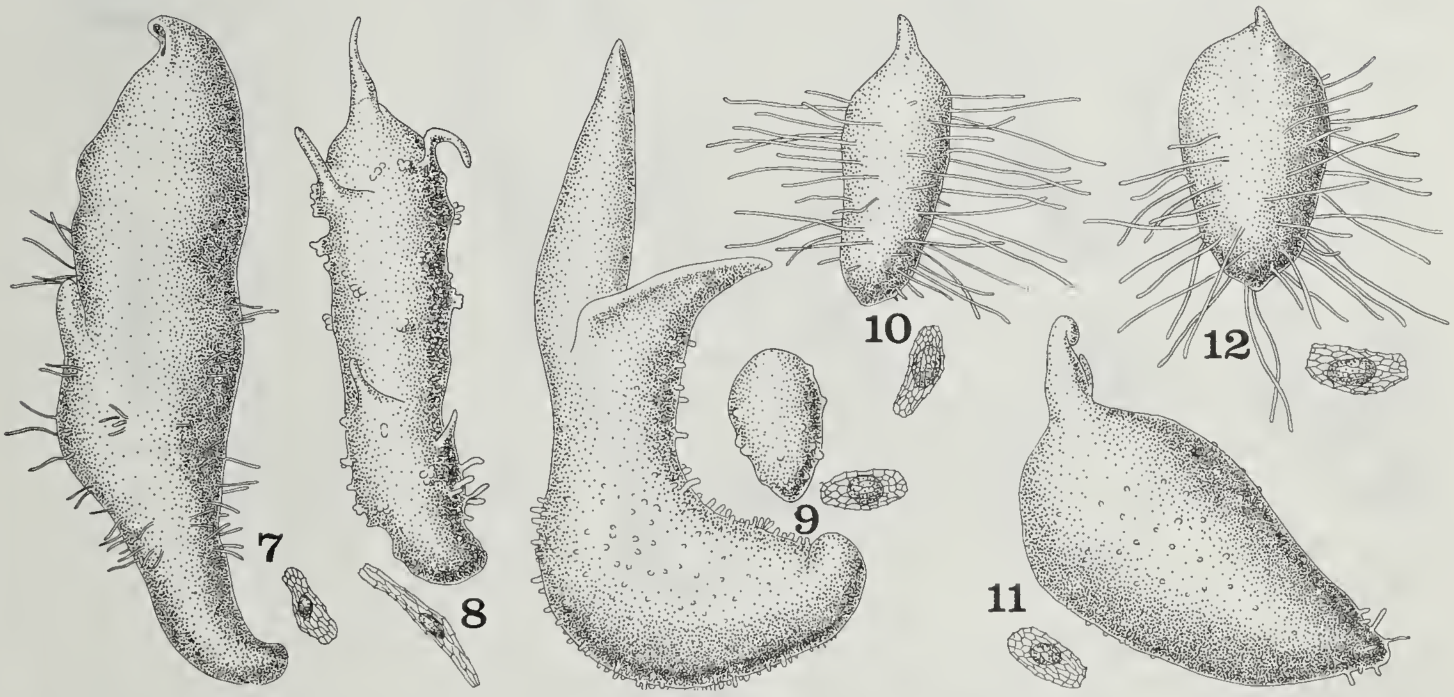
Fig. 1-6. Seeds and seedlings, x27. (In Figs. 1-19, accession number in parentheses is followed by number of months plant had been in culture when drawn.)

Fig. 1. *Cypripedium acaule* (4064), 13 mo.
Fig. 2. *Cypripedium reginae* (4065), 15 mo.
Fig. 3. *Habenaria hookeri* (3512), 36 mo.
Fig. 4. *Listera cordata* (4059), 15 mo.
Fig. 5. *Goodyera pubescens* (3835), 20 mo.
Fig. 6. *Goodyera pubescens* × *repens* (3303), 52 mo.

These are not plants of the shaded, well drained forest floors, but occur along ditches, in wet meadows, in low sandy depressions, and in more open areas of *Sphagnum* bogs. These species are most exposed to sunlight, and their seedling stages would be most likely to benefit by starting photosynthesis at an early stage.

Seeds of several *Habenaria* species and their artificially produced hybrids are being grown here. The only signs of growth for the first 4-6 months in culture have been a slight swelling of the embryo within the seed coat, and the production of rhizoids. The embryo then turns green, and growth speeds up markedly. Figure 9 is an illustration of *Habenaria ciliaris*, the Orange-fringed Orchid. This has grown most rapidly, while the closely related *Habenaria blephariglottis* (White-fringed Orchid) also develops, but at a slower rate (Fig. 10). Mr. Case has found well developed, colorless, leafless seedlings of these species in nature. These two species are apparently able to develop without chlorophyll when buried in their native bogs.

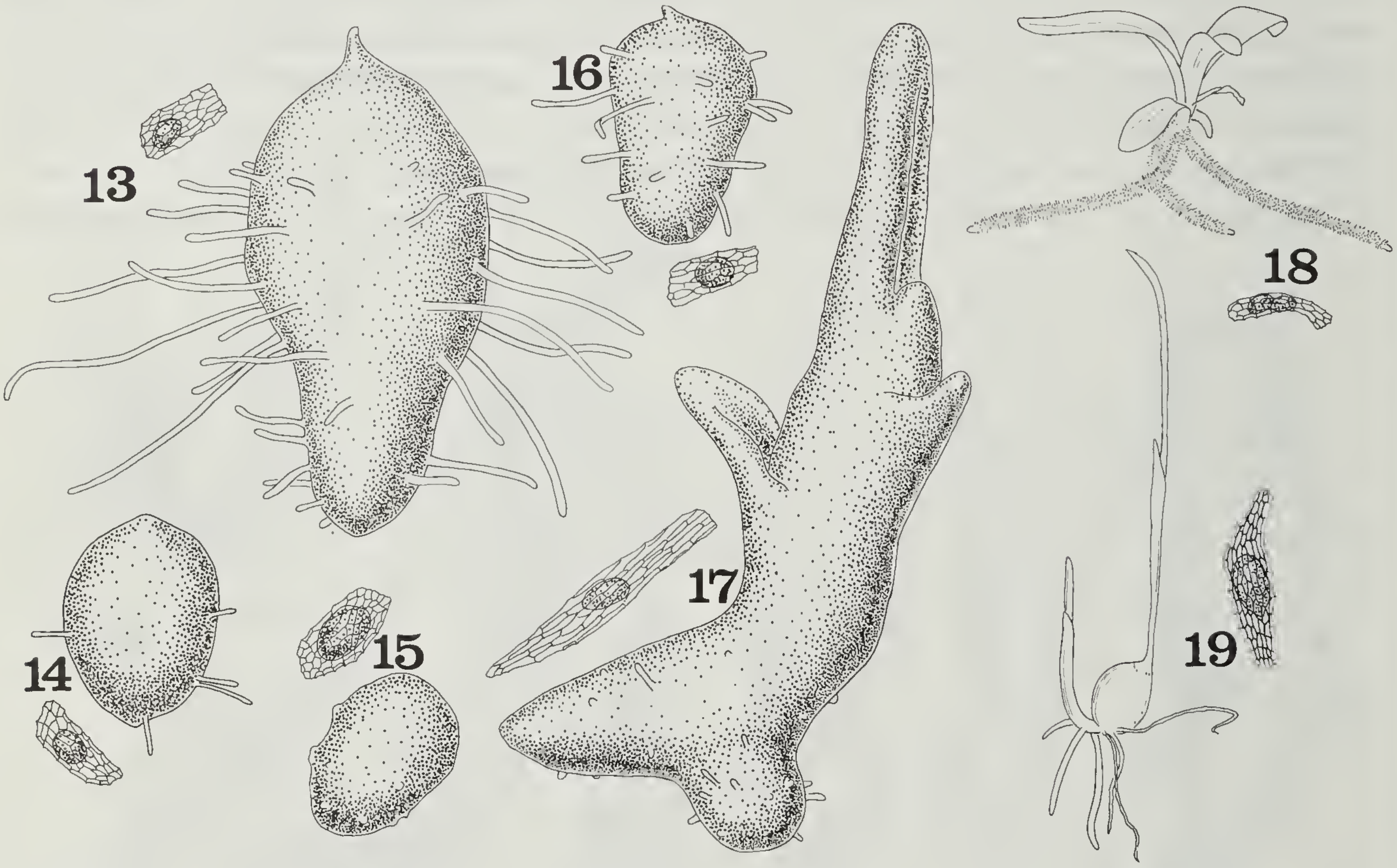
Pollen of other *Habenaria* species was supplied by Mr. Case and was placed on the stigmas of *H. ciliaris* and *H. blephariglottis*. The ripened seed capsules were collected and seeds planted in the usual manner. Protocorms have been produced in several cases but I will not be certain of their hybrid nature until flowering. In all experimental crosses, I follow the convention of listing the female or seed parent



Figs. 7-12. All seeds, x16; seedlings, x 6.

Fig. 7. *Liparis loeselii* (3397), 41 mo.
Fig. 8. *Goodyera oblongifolia* (4077), 12 mo.
Fig. 9. *Habenaria ciliaris*, seed with two seedlings of same age, showing differences in growth rate occurring in same culture. (4089), 14 mo.
Fig. 10. *Habenaria blephariglottis* (4082), 14 mo.
Fig. 11. *Habenaria ciliaris* x *blephariglottis* (4088), 14 mo.
Fig. 12. *Habenaria blephariglottis* x *psycodes* (4086), 14 mo.

first. Self fertilization has been reported for several of the species occurring in the Great Lakes region by Hagerup (1952) and some of the plants being grown here could be species rather than interspecific hybrids. *Habenaria ciliaris* × *blephariglottis* (Fig. 11) has been found in Michigan by Mr. Case and in North Carolina by Hardin (1961). The only apparent difference between the parental species is in the yellow versus the white flower color. *Habenaria ciliaris* × *leucophaea* (Fig. 13) has not been reported in nature. The second parent is the robust Prairie White-fringed Orchid, with racemes of comparatively large white flowers. *Habenaria ciliaris* × *psycodes* also has no natural counterpart (Fig. 14). Here the second parent is the Small Purple-fringed Orchid. *Habenaria blephariglottis* × *psycodes* (Fig. 12) is another hybrid combination unreported from the field. *Habenaria blephariglottis* × *leucophaea* (Fig. 15) has produced small, slow growing protocorms which lack the vigor of other combinations reported



Figs. 13-19. All seeds, x20; seedlings of Figs. 13-17, x8; seedlings of Figs. 18-19, x2.

Fig. 13. *Habenaria ciliaris* × *leucophaea* (4087), 12 mo.
Fig. 14. *Habenaria ciliaris* × *psycodes* (4090), 14 mo.
Fig. 15. *Habenaria blephariglottis* × *leucophaea* (4083), 14 mo.
Fig. 16. *Habenaria blephariglottis* × *lacera* (4085), 14 mo.
Fig. 17. *Pogonia ophioglossoides* (4074), 14 mo.
Fig. 18. *Spiranthes cernua* (4133), 13 mo.
Fig. 19. *Calopogon pulchellus* (3330), 44 mo. This plant is beginning its fourth cycle of growth.

here. Both parental species produce showy white flowers. In *Habenaria blephariglottis* × *lacera* (Fig. 16) the second parent is the Ragged-fringed Orchid, a widespread species whose form and coloration often make it difficult to find. This hybrid is not known in nature.

The differences in rhizoid length in the figures are probably not of great significance. Rhizoid length varies greatly on different regions of single protocorms, and is strongly affected by the local conditions. Rhizoids projecting above the medium are frequently 2-3 times as long as those growing into the agar.

Pogonia ophioglossoides, the Rose Pogonia (Fig. 17), is a plant of open *Sphagnum* hummocks and wet sedgy areas. Its seeds produce green elongate seedlings which develop small bulbous offsets. The species spreads through the peaty areas in which it grows by producing new shoots from its wide-spreading root system.

Spiranthes cernua, the Nodding Ladies' Tresses (Fig. 18) has a comparatively rapid seed and seedling development. Seeds ripen very soon after flowering and each seed contains several embryos. The seeds are accompanied by large cell masses which are free in the seed capsule. Embryos develop chlorophyll within two weeks of being placed in sterile water, and their subsequent development is also rapid. Rosettes of leaves and a well developed root system develop and plants appear to be of flowering size 2 years after seed was started. This rapid development might be predicted from the natural habitat of the plant: it often is found on soil which has been disturbed by man, or in areas which are in an active state of transition from one type of vegetation to another.

The most rapid seedling development of any of the Great Lakes orchid species occurs in *Calopogon pulchellus*, the Grass Pink (Fig. 19). Seeds turn green within 2 weeks of planting on agar or in sterile water, and quickly grow into 2-3 mm green protocorms. A shoot develops, and the first leaf is 2-3 cm long within 3-4 months. This shoot dies back, and the small green corm which developed at its base lies dormant indefinitely at room temperature. The dormancy is broken by refrigeration of 4-6 weeks duration, after which a new shoot develops from the corm's base, starting the next growth cycle. I have plants which are now in their fourth growth cycle, with some 8 cm leaves. The growth cycles require only 3-5 months to go to completion, and it is possible to induce the equivalent of two years growth in one year with these methods.

These seed germination studies are continuing, with special emphasis on the more recalcitrant species. A major problem here is the inconsistent supply of orchid seed with which to work. Any reader who knows of native orchid colonies and who could gather ripe or ripening capsules for germination tests is encouraged to do so, and send them to me. I have not been able to procure seeds of the following Great Lakes orchids:

Habenaria orbiculata	Round-leafed Rein-orchid
Habenaria viridis	Long-bracted Rein-orchid
Listera auriculata	Auricled Twayblade
Listera convallarioides	Broad-lipped Twayblade
Malaxis paludosa	Bog Adder's Mouth
Malaxis unifolia	Green Adder's Mouth
Orchis rotundifolia	Small Round-leafed Orchid
Spiranthes gracilis	Slender Ladies' Tresses
Spiranthes lucida	Shining Ladies' Tresses
Tipularia discolor	Crane-fly Orchid
Triphora trianthophora	Three Birds Orchid

Seeds of these or other species can be placed in folded, unwaxed paper, and mailed in envelopes. Capsules should be collected in moderation if the species is rare or if few plants make up the colony. Removing the entire seed crop will not harm the mature plants, but it will prevent reproduction for that year. Seed capsules collected with moderation will do little harm to the population and may add considerable to our knowledge of the growth of these plants.

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On the Cover

Myriostoma coliforme (Pers.) Corda is a rare gasteromycete growing mostly in sandy areas. It is most closely related to *Geastrum* (the earth-stars), but instead of having only one pore from which the spores escape there are several. We need more records of this species for Michigan. Anyone finding it please send it to the University of Michigan Herbarium.

The superb collection illustrated (about twice natural size) on the cover was found by Dr. James Maniotis, Department of Biology, Wayne State University, at Point Pelee National Park, Ontario, Canada, July 18, 1962, in sandy soil containing leaf litter in a mixed hardwood—juniper forest.

—A. H. Smith

MYXOMYCETE SPORE LONGEVITY

Frederic H. Erbisch
Michigan Technological University, Houghton

In November of 1960, spores of three species of Myxomycetes ("slime-molds") were obtained from collections in the University of Michigan Herbarium. The species included in this study were *Hemitrichia clavata* (Pers.) Rost., *Lycogala flavofuscum* Rost., and *Fuligo septica* (L.) Gmel.

In order to compare spore longevity, spores of specimens collected in different years were obtained. Three periods were chosen: (1) the oldest collection available of each species, (2) the most recent collection available, and (3) collections intermediate to the oldest and most recent collections (see Table 1).

To get the spores to germinate the following treatment was given (from Elliott, 1949). The spores were covered with a 1.0% bile salt solution (sodium glycocholate) for one-half to one minute, after which the bile salt solution was diluted with distilled water and centrifuged. The liquid was poured off and the spores were washed twice with distilled water. The treated and washed spores were mixed with norite water and placed in watch glasses. The watch glasses with the spore solutions were placed in the dark and kept at room temperature. The cultures were examined 48, 72, and 96 hours after the germination treatment.

OBSERVATIONS

The 48-hour examination showed that all spore cultures had germinated except *Fuligo septica* - 1899; however, not all had germinated to the same extent (see Table 1). After 72 hours, all cultures were observed to have germinated, but again not to the same extent. The 96-hour examination showed all cultures to have germinated to about the same extent.

Drawings and measurements of swarmers from the oldest and most recent spore collections of each species were made. (The swarmers were fixed and killed in an IKI solution.) These showed there was no apparent size difference between the swarmers of the different age groups of spores. Each swarmer was observed to have two flagella, generally one long and one short; however, some were observed to have two long or two short flagella. The swarmers from the older spore collections moved noticeably slower than those of the more recent spore collections at 96 hours.

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Elliott, Eugene W. 1949. The swarm-cells of Myxomycetes. Mycologia 41: 141-170.

TABLE 1. Amount of Myxomycete spore germination over a 96-hour period. Slight germination is less than 10%; moderate germination, 10% - 50%; abundant germination, more than 50%. (All collections from Michigan.)

Species	Collector	Date	Germination at		
			48 hours	72 hours	96 hours
Hemitrichia clavata	V. M. Spalding	1885	moderate	abundant	all had abundant germination at 96 hours
H. clavata	F. E. Langdon	1895	slight	moderate	
H. clavata	M. V. Cannon	1914	moderate	abundant	
H. clavata	J. Drummond	1932	slight	moderate	
Lycogala flavofuscum	A. J. Pieters	1892	moderate	abundant	
L. flavofuscum	C. H. Kauffman	1915	moderate	abundant	
L. flavofuscum	E. B. Mains	1931	moderate	abundant	
L. flavofuscum	E. B. Mains	1950	moderate	abundant	
Fuligo septica	J. B. Pollock	1899	none	slight	
F. septica	J. B. Pollock	1904	moderate	abundant	
F. septica	A. H. Povah	1930	moderate	abundant	
F. septica	C. Smith	1944	slight	moderate	

Review

WILD PLANTS IN FLOWER. Plates xlii to xlix. Torkel Korling, Box 4618, Chicago, Illinois 60680. 8 color plates (16 x 22 in) + descriptive text. 1963. $12.00

Those who are familiar with the superb color photography of Torkel Korling do not need to be assured that this boxed portfolio of eight large reproductions is a thing of beauty. Two of the subjects, Showy Lady's-slipper *(Cypripedium reginae)* and Fringed Gentian *(Gentiana procera)* were photographed in Oakland County, Michigan. No locality is given for *Camassia scilloides;* the others *(Brodiaea elegans, Castilleja miniata, Mentzelia laevicaulis, Carduus nutans, Geum triflorum)* were photographed from Illinois to Washington.

The accompanying text (printed on one side of a covering folder, thus easily clipped and attached to the back of framed prints) is written in a refreshing style.

Mr. Korling is widely known in other than botanical circles as a skilled professional photographer, chiefly of industrial processes. Certain of his floral portraits have appeared previously in advertising ventures, some in a format similar to the present portfolio. (Evidently 41 subjects have previously been published; this first series to be sold to the public begins with no. 42.) We understand that additional plates in the same format will be issued when possible.

In addition to the obvious artistic and scientific merit of these portraits, they will, it is to be hoped and expected, lead those fortunate enough to view them to look more closely at their environment. School children (and their elders) exposed to such pictures on the walls of a classroom, library, or conference room will be assured of the "Glory by the Wayside" which awaits the appreciative, understanding, and friendly eye—the eye which Mr. Korling obviously has behind his own camera.

E. G. V.

INDEX TO VOLUMES 1-3

With the exceptions here noted, this index is intended to be complete for the three volumes, including all scientific names, titles (by important words), authors, and subjects. NOT indexed are the following: news items, program notes, announcements, etc.; items in literature lists, bibliographies, and summaries; common names except when there is a major discussion or use of them. Most references to persons are not indexed unless of special importance to the subject matter of the article itself. Names of persons not followed by a title refer to information about the person. Infraspecific epithets (subspecies, varieties, forms) are omitted from listings unless the infraspecific taxon as such is actually the subject of discussion. Cover pictures are indexed under the explanations of them (usually the last page of an issue). The attention of phytogeographers is called to the special entry, "Distribution Maps," where all species are listed for which partial or complete maps have been published. A list of new names and combinations appears at the end of the index.

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(On the cover: Myriostoma coliforme from Point Pelee, Ontario, photographed by James Maniotis. See p. 119.)

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